

Investigation of the Potential Impact of Real Atmospheres on Predicted X-59 QueSST Aircraft Sonic Boom Ground Signatures



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CST Project
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Outline

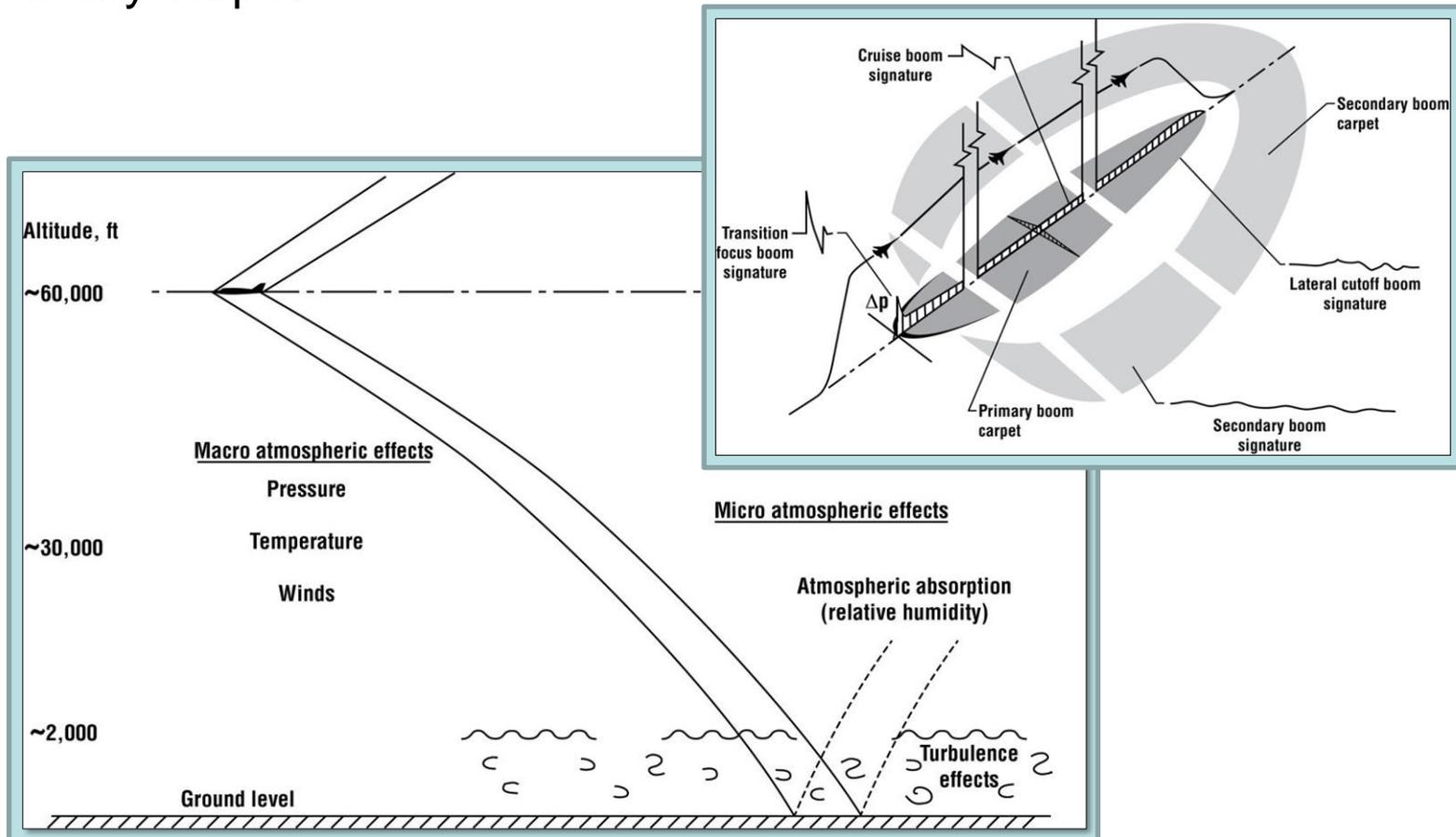


- Background & Objectives
- LBFD Baseline
- Study Variables
- Results
- Summary

Sonic Boom Analysis



- sBOOM propagation code used for analysis
- Turbulence effects not included
- Primary carpet



LBFD Aircraft

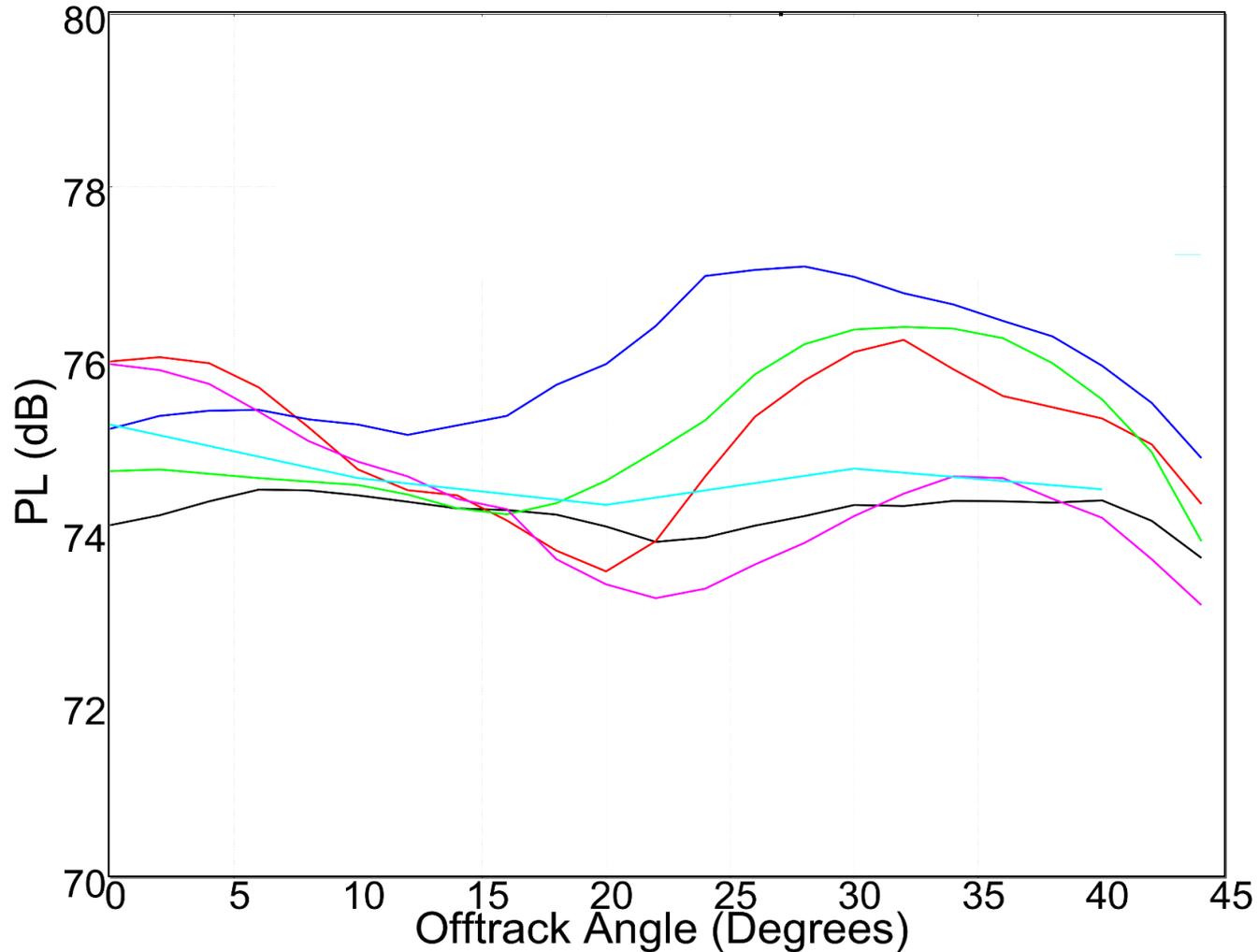


~ 95' in length
~ TOGW of 24,000lbs
~ 50-55Kft cruise altitude
Cruise Mach 1.4

LBFD Nearfield Pressure Signature



- Typical nearfield pressure distribution variations across CFD codes



Study Variables



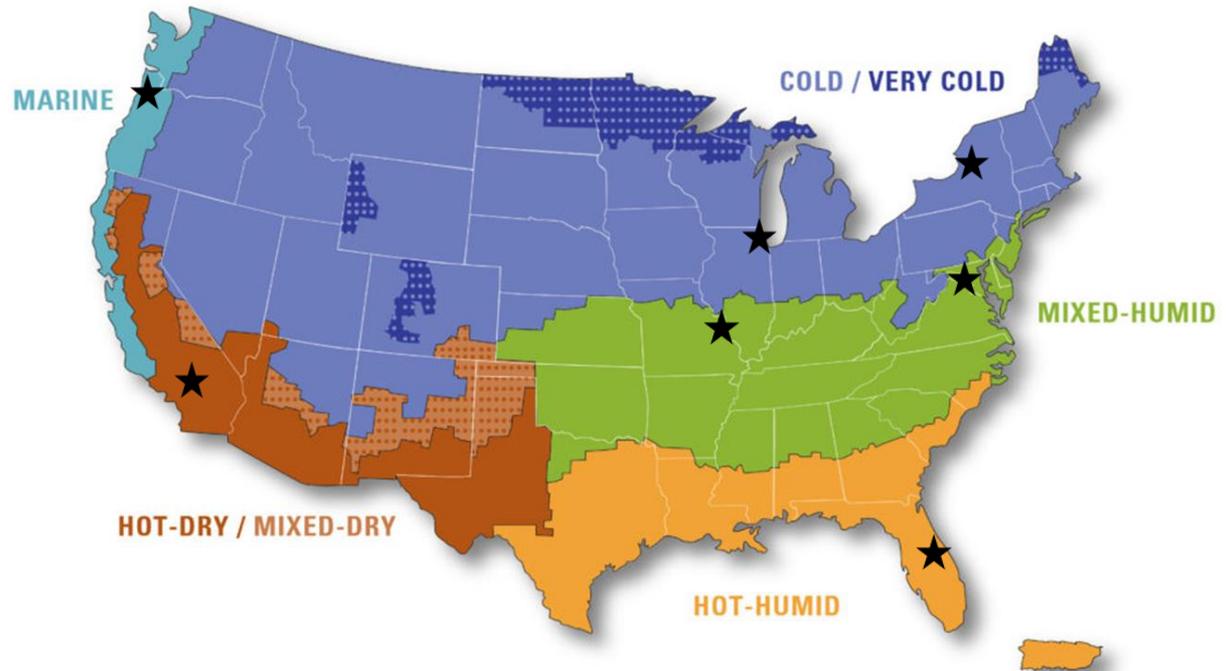
- Temperature*
- Winds*
- Humidity*
- Location
- Time of day
- Time of year
- Aircraft heading angle
- Primary carpet $\pm 44^\circ$

* Atmospheric Data obtained from NOAA NCEP/NCAR
Reanalysis Database

Locations Studied



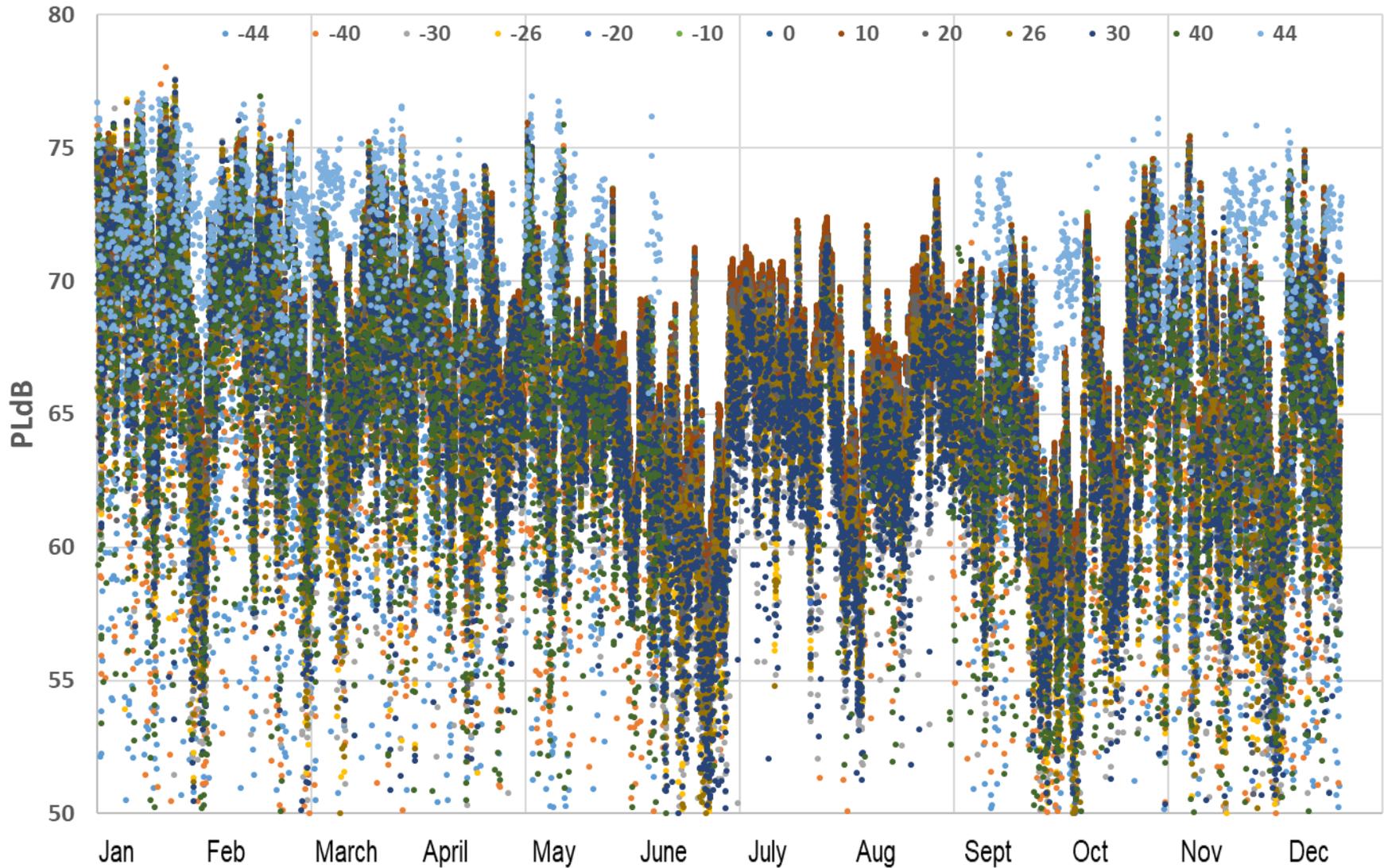
- Marine
 - Portland, OR
- Hot-Dry
 - Lancaster, CA
- Cold
 - Chicago, IL
 - Syracuse, NY
- Mixed-Humid
 - St. Louis, MO
 - Arlington, VA
- Hot-Humid
 - Orlando, FL



Sample Yearly Data



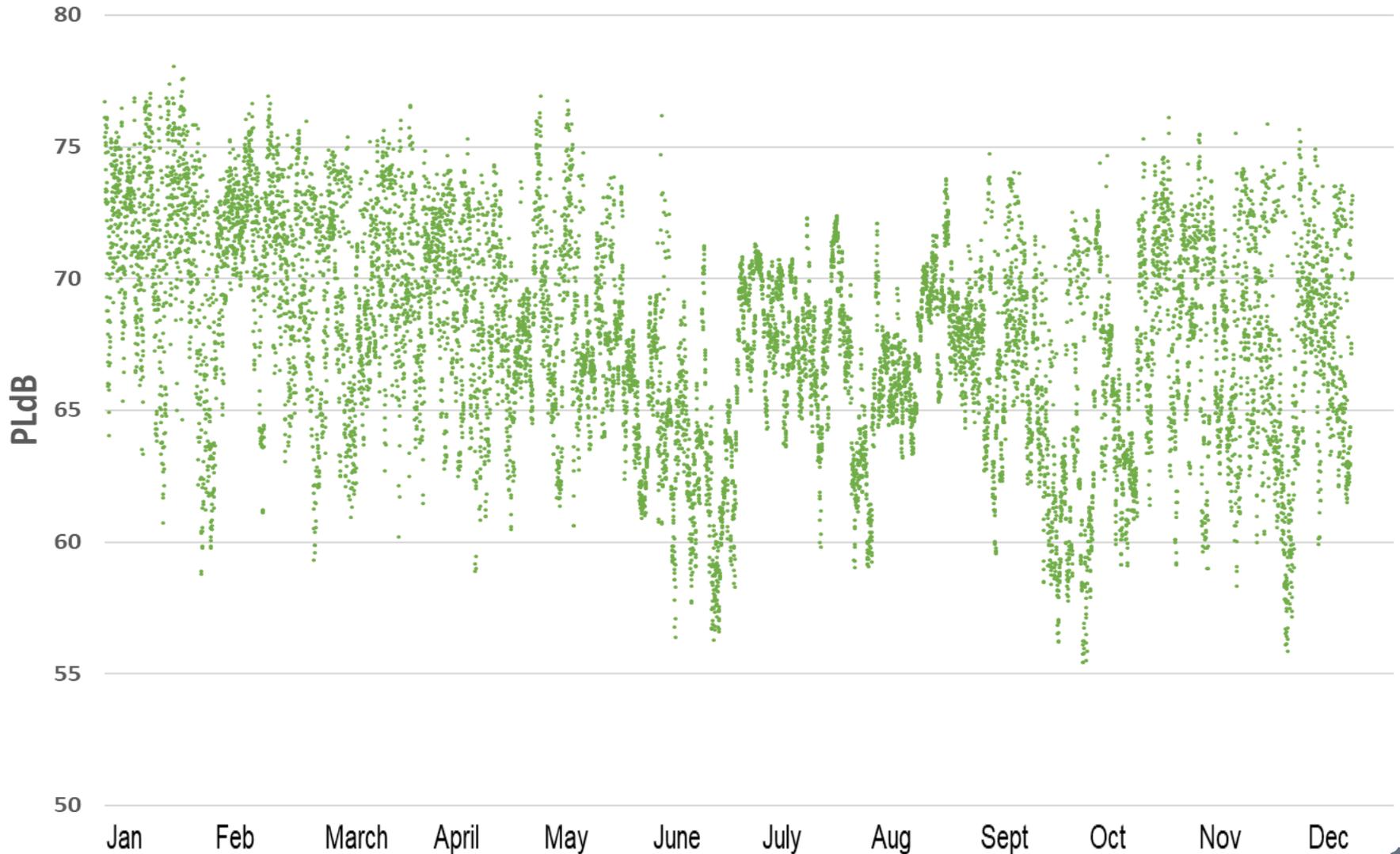
Carpet Data for 2017



Sample Yearly Data



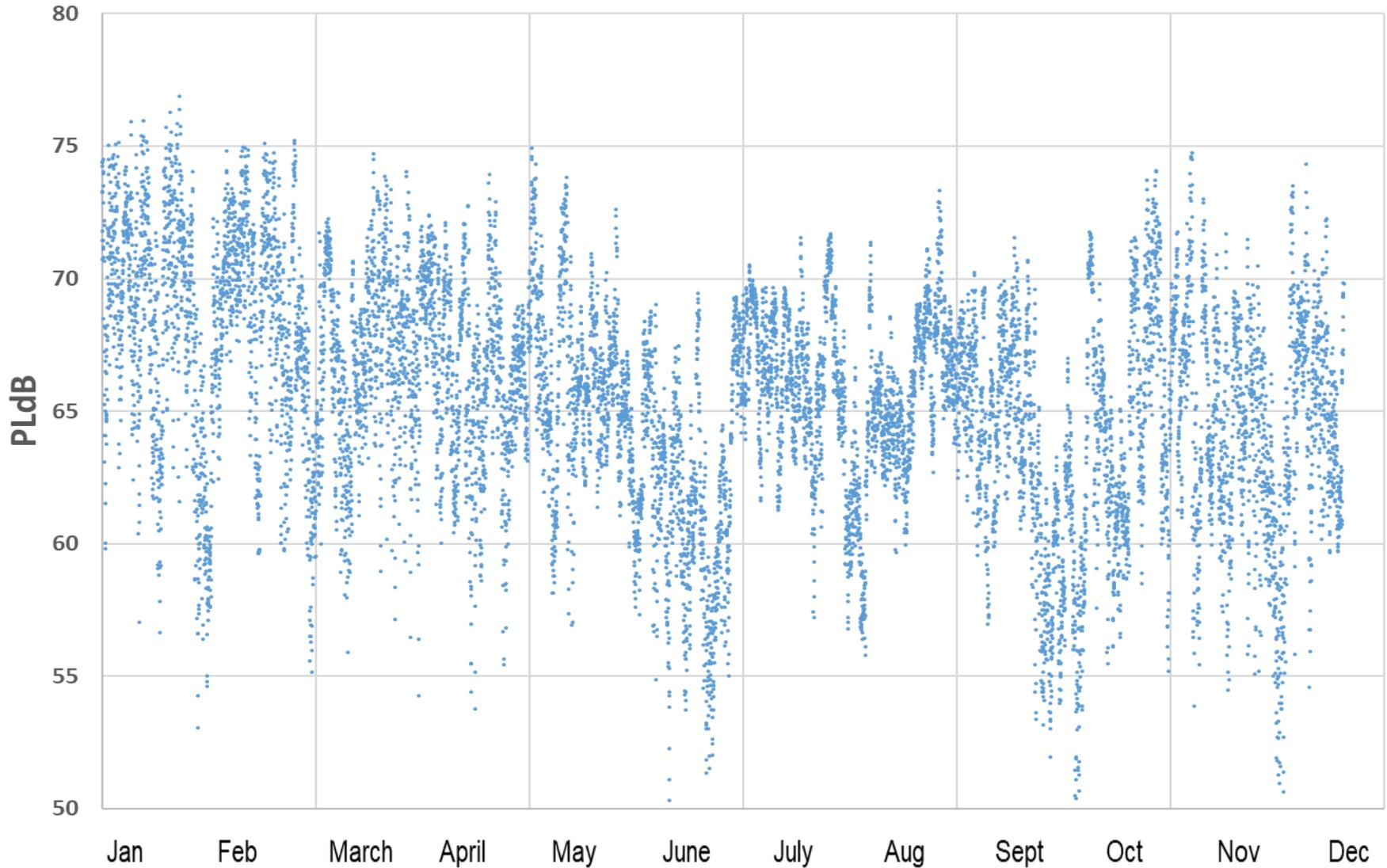
Maximum Carpet Loudness



Sample Yearly Data



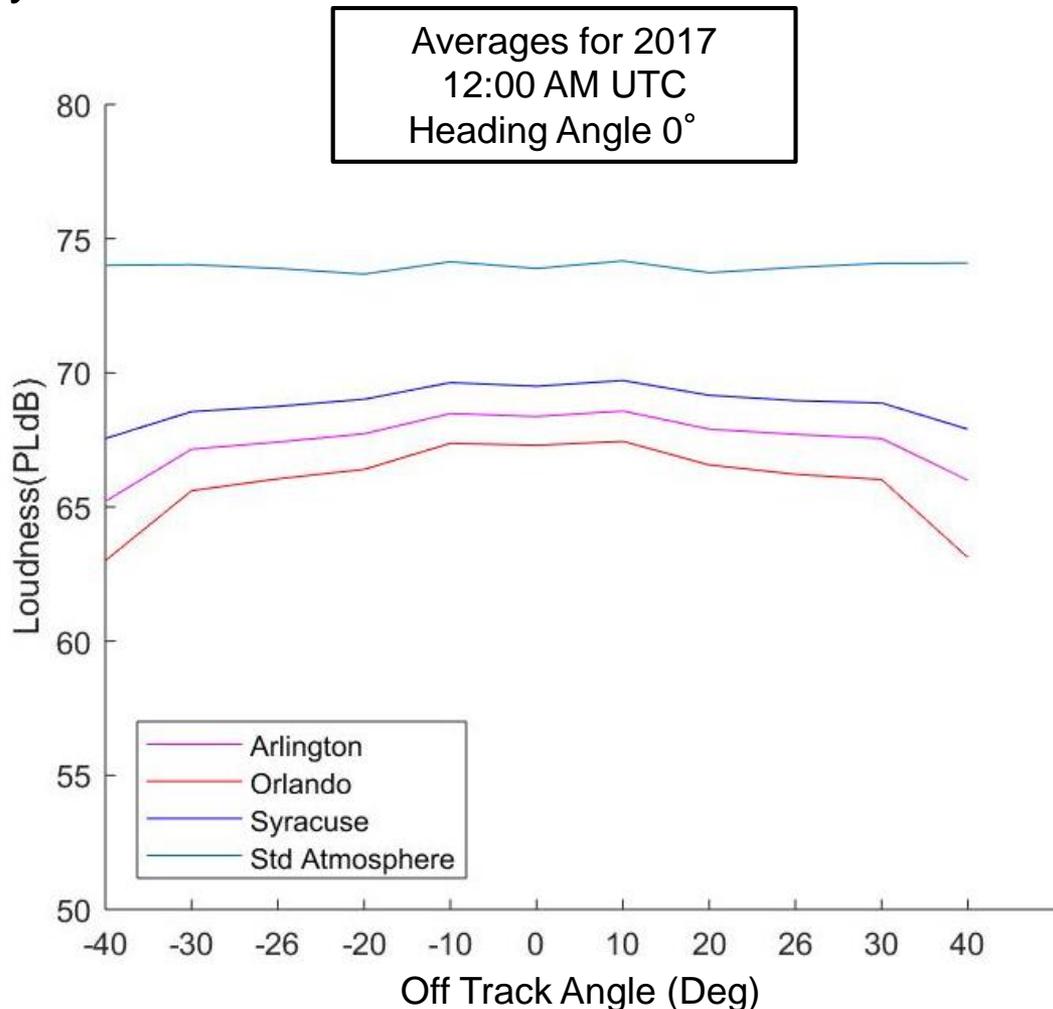
Average Carpet Loudness



Standard Atmosphere vs Real Atmospheres



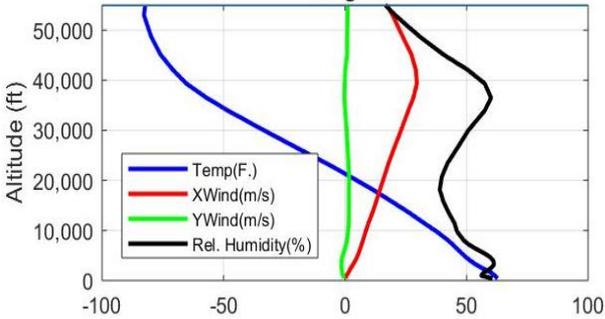
- Standard atmosphere is significantly louder than any real atmospheric data analyzed



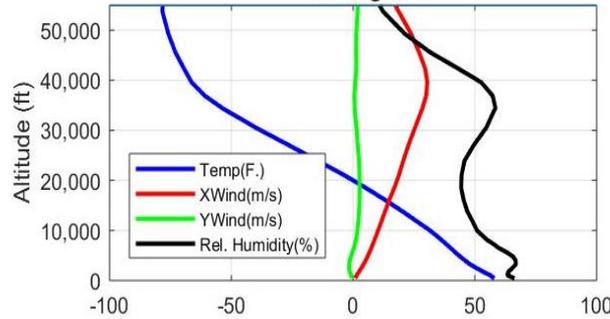
2017 Average Atmospheric Data



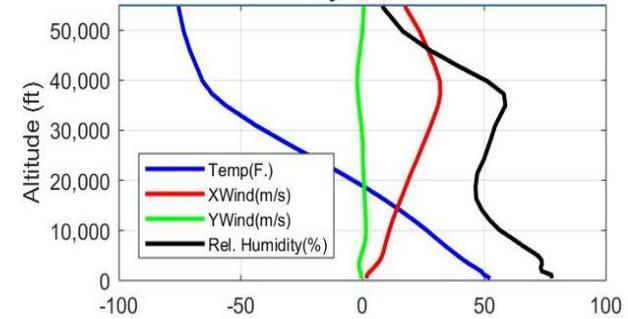
Oregon



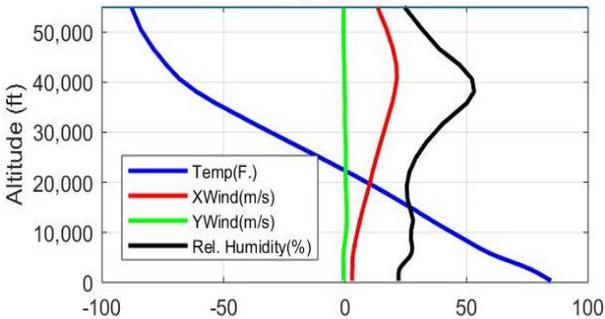
Chicago



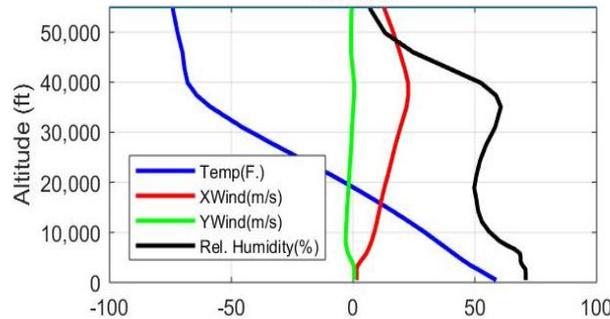
Syracuse



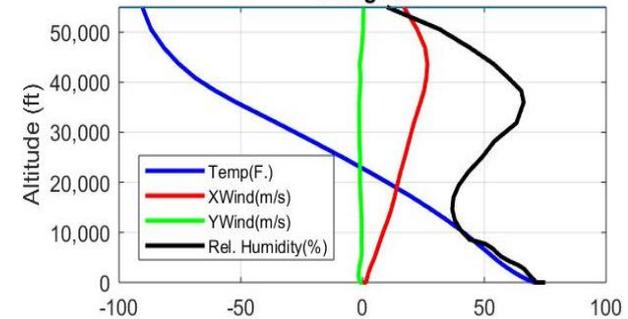
Lancaster



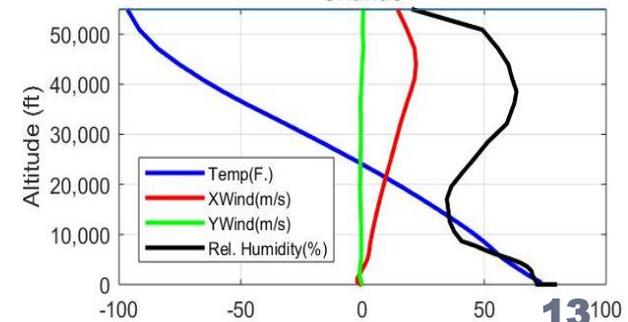
St.Louis



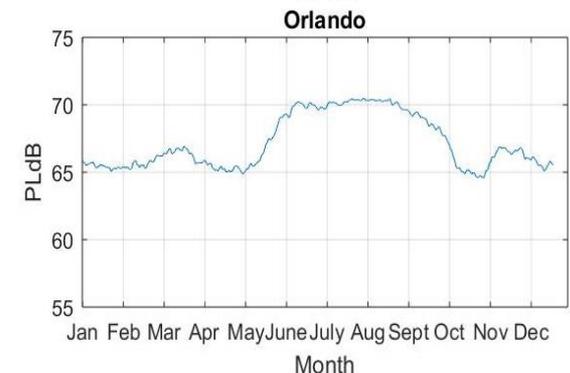
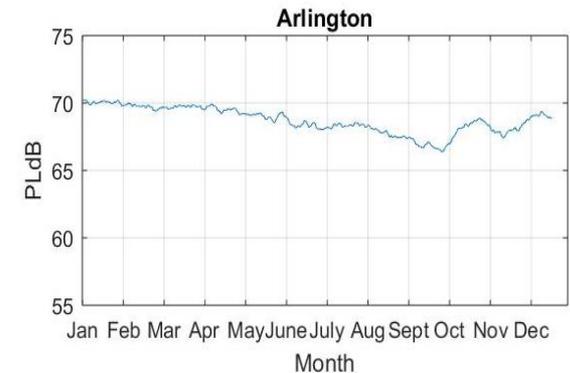
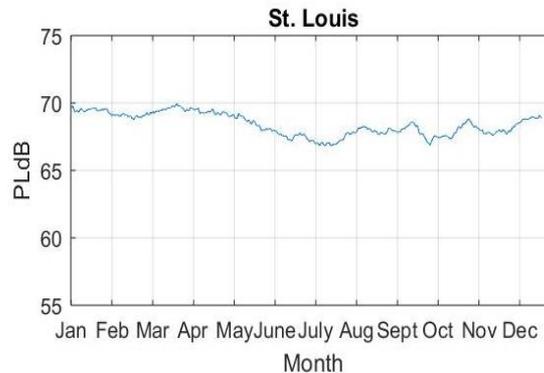
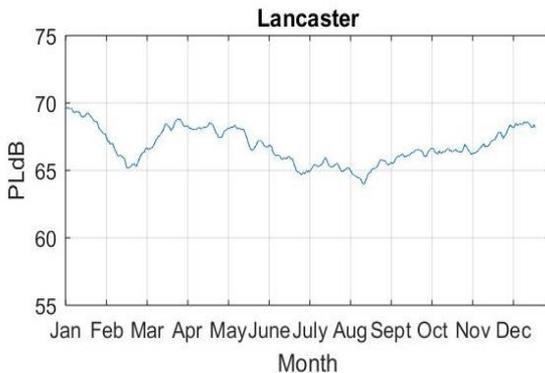
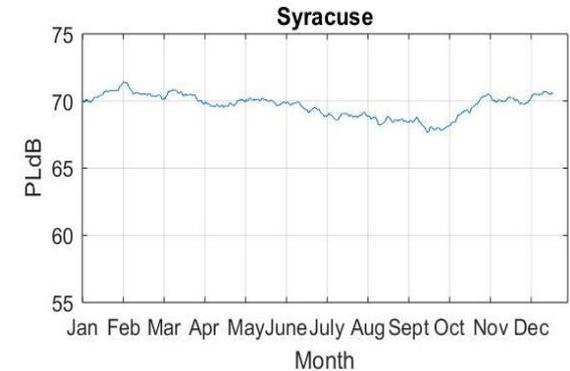
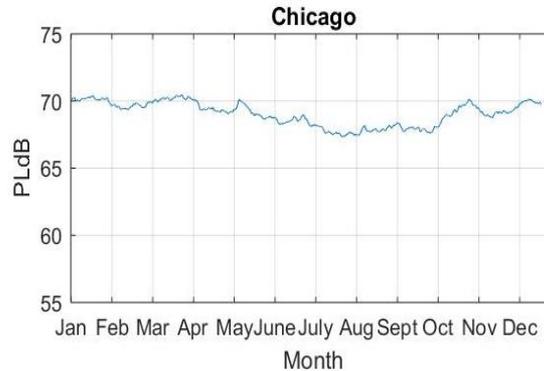
Arlington



Orlando

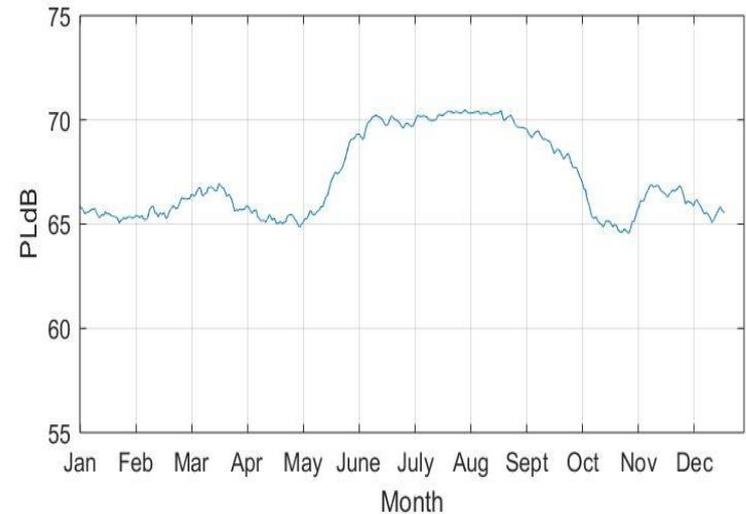
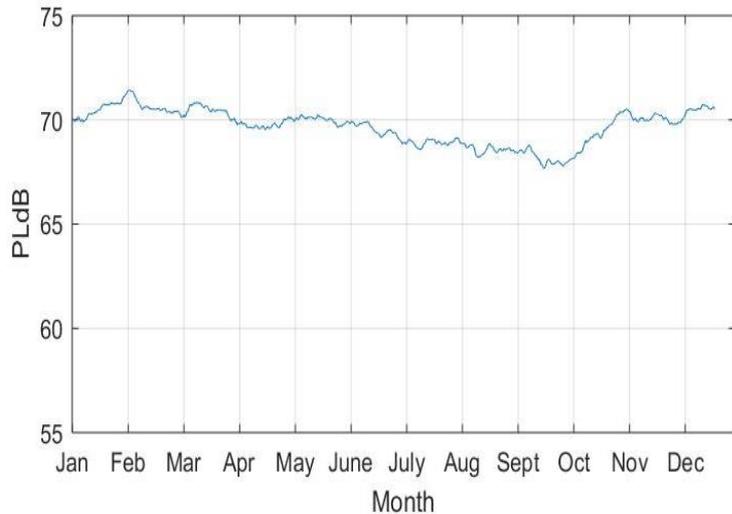
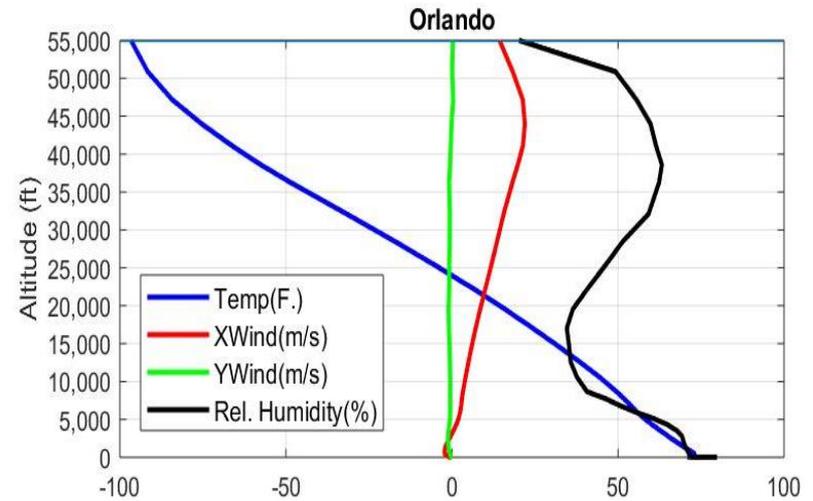
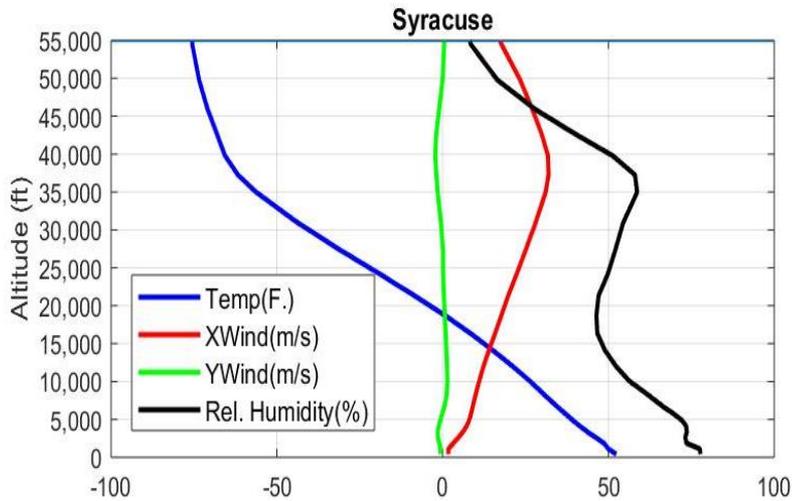


Seasonal Variation at All Locations (2017)

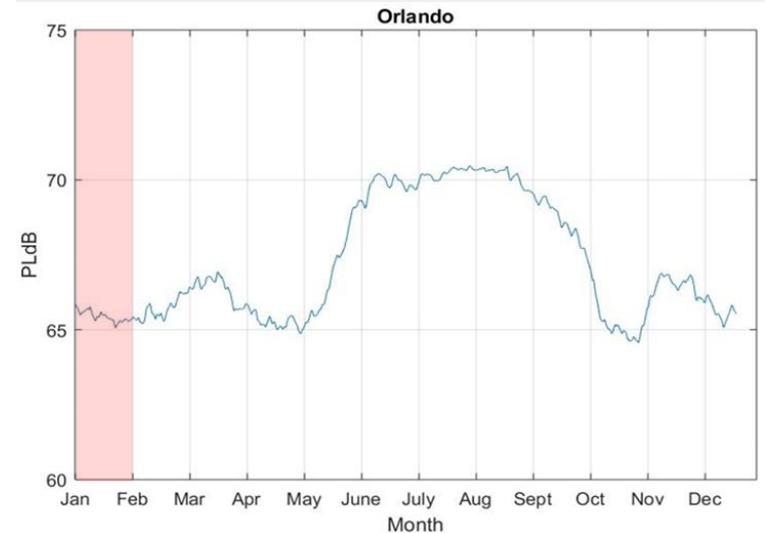
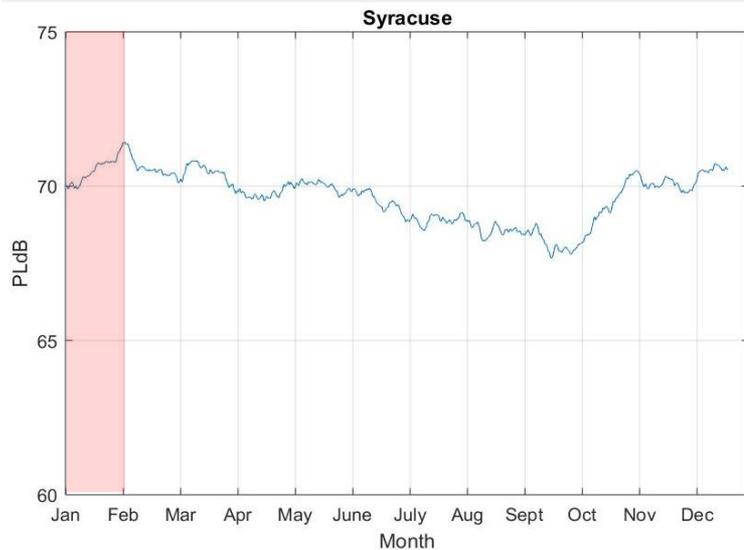
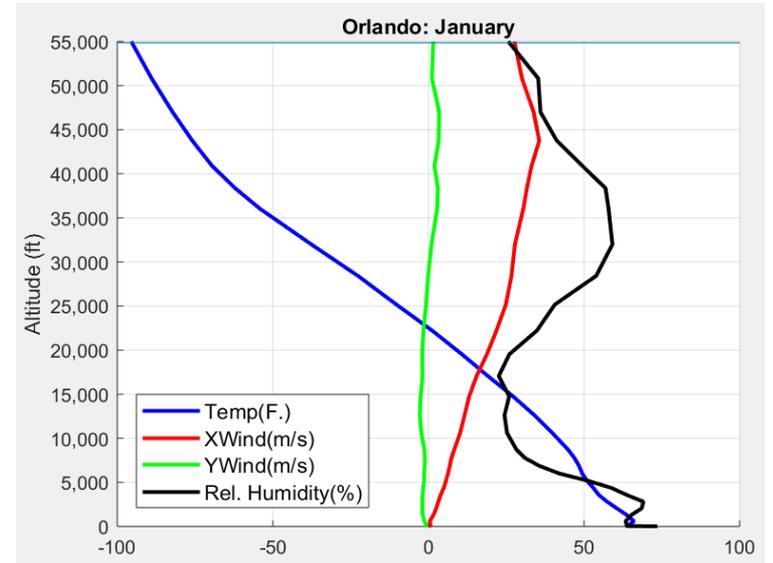
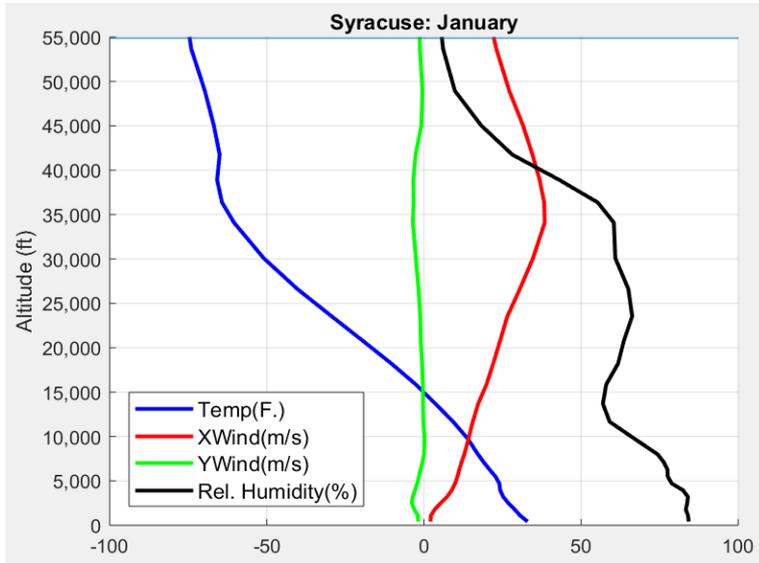


- All 4 time indexes
- Heading angle of 0°
- Moving average of the data

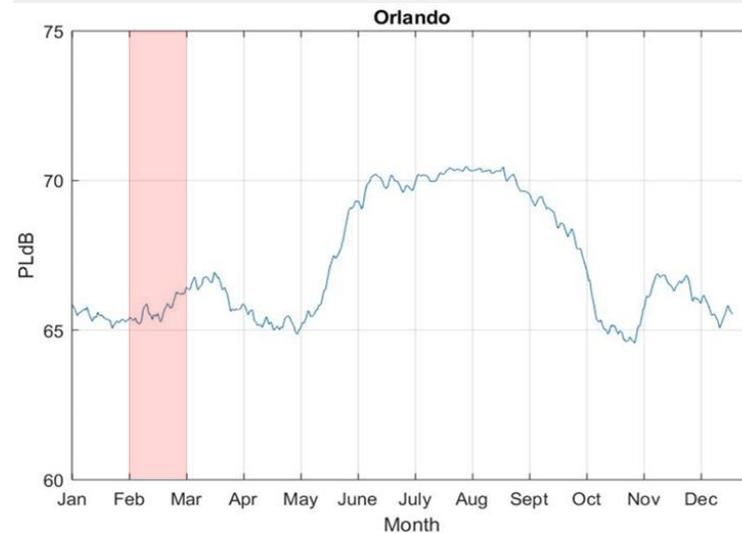
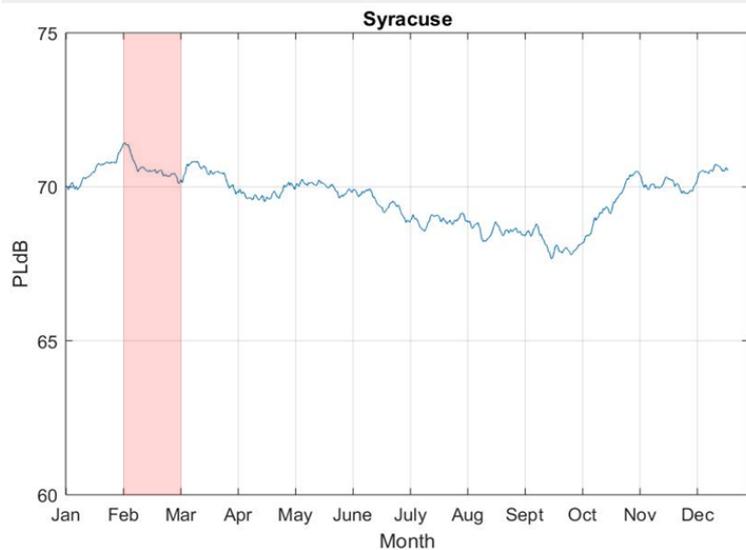
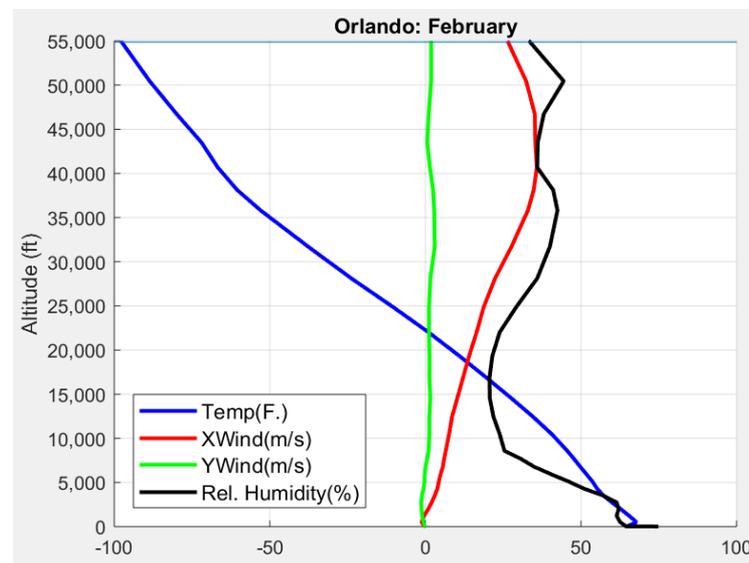
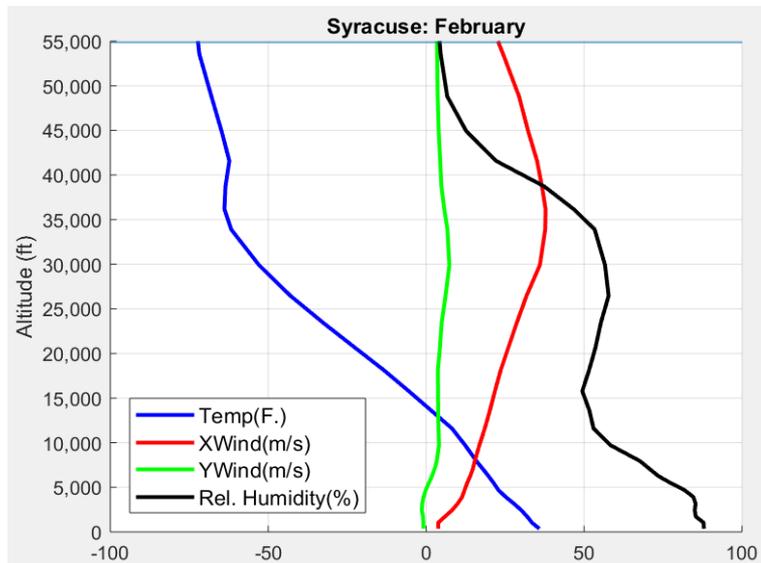
2017 Average Atmosphere and Loudness



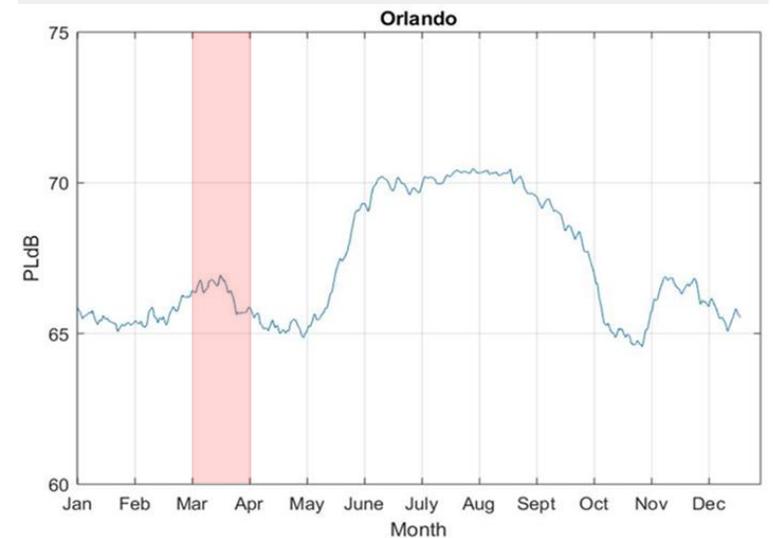
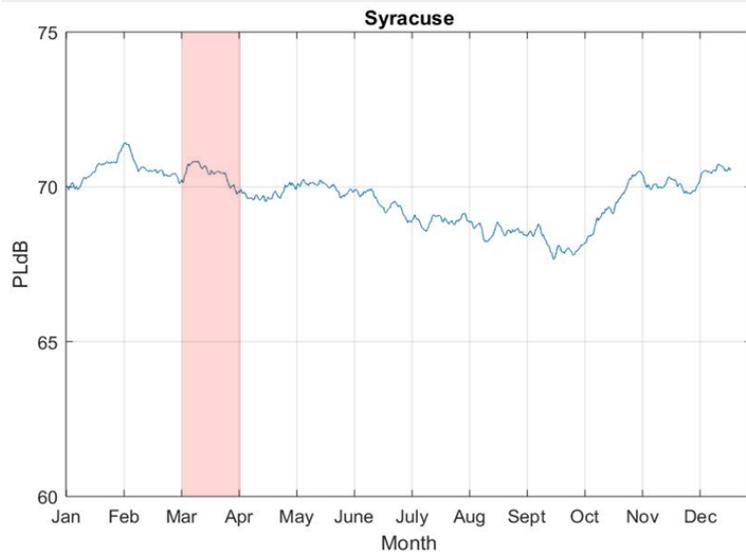
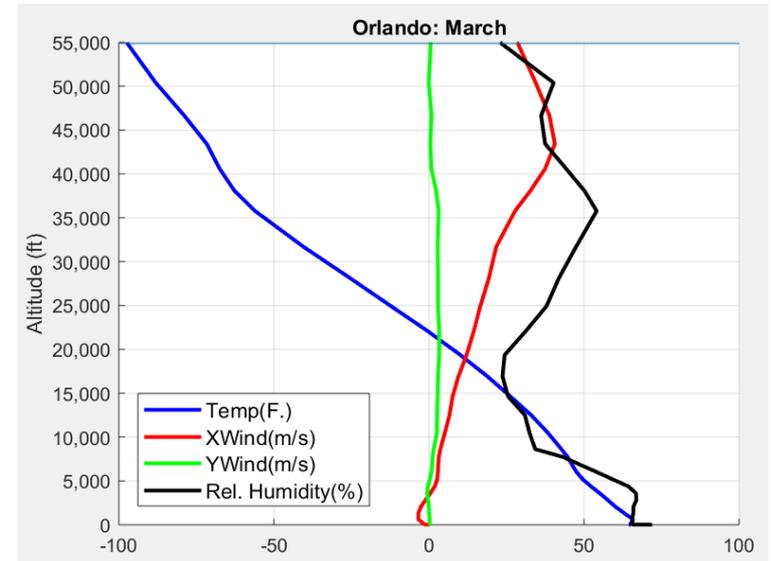
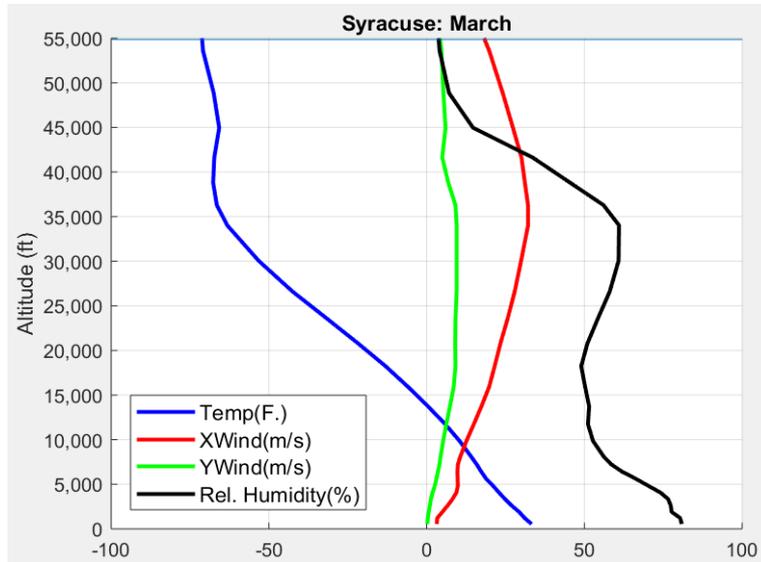
Monthly Atmospheric Variation



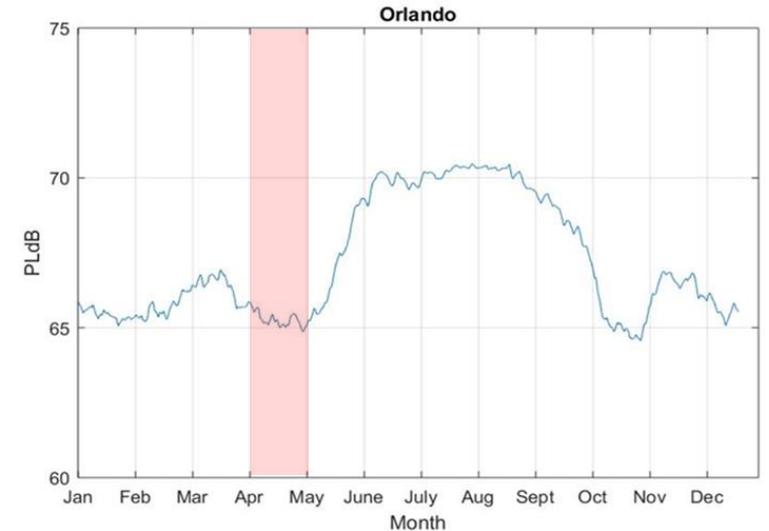
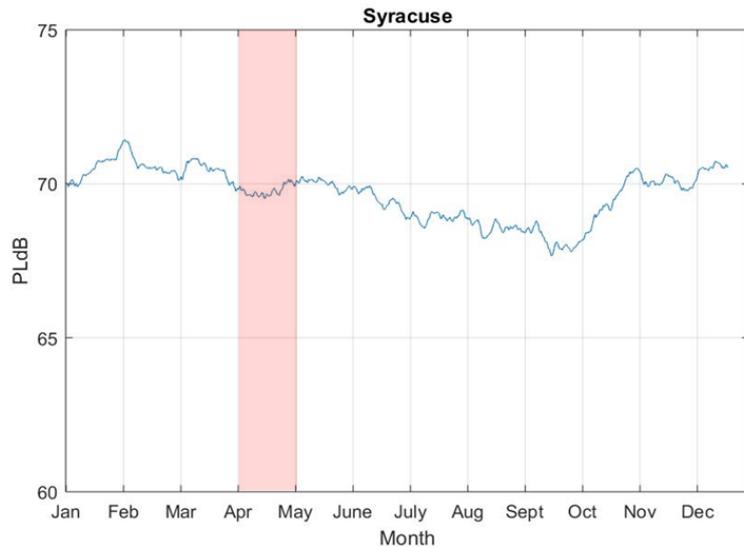
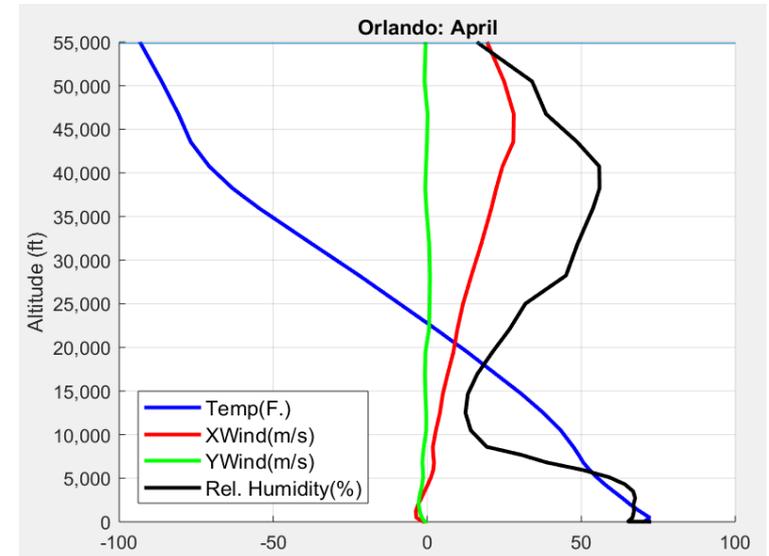
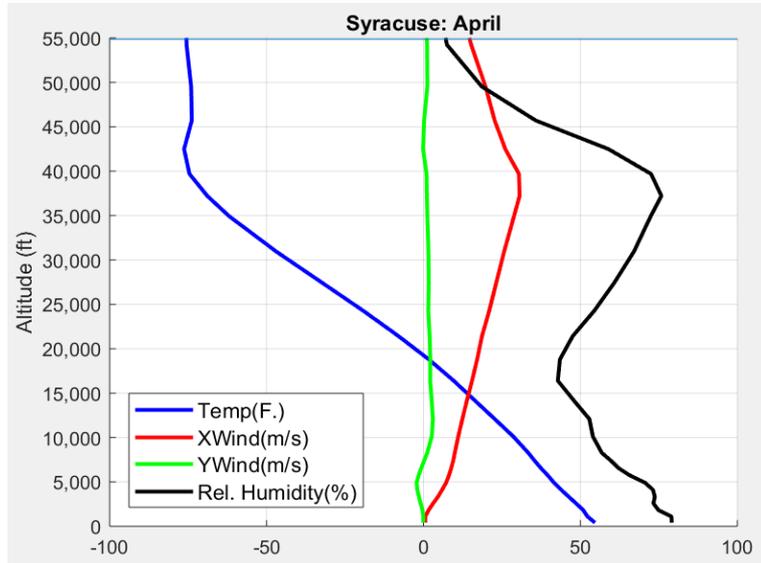
Monthly Atmospheric Variation



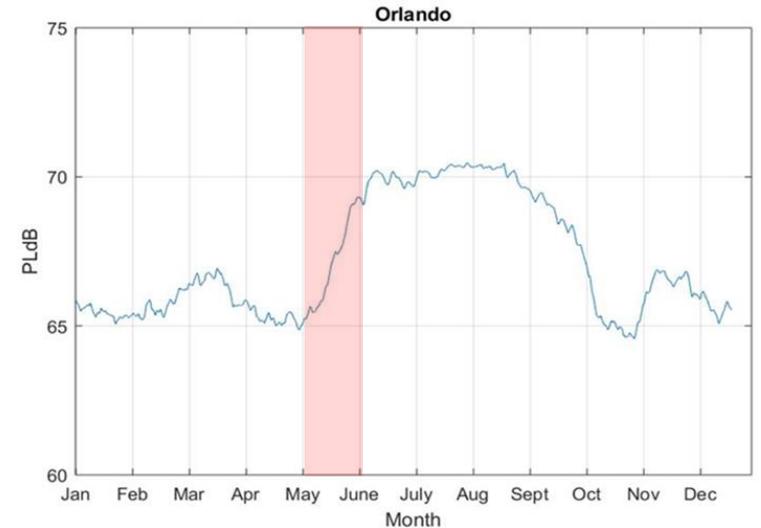
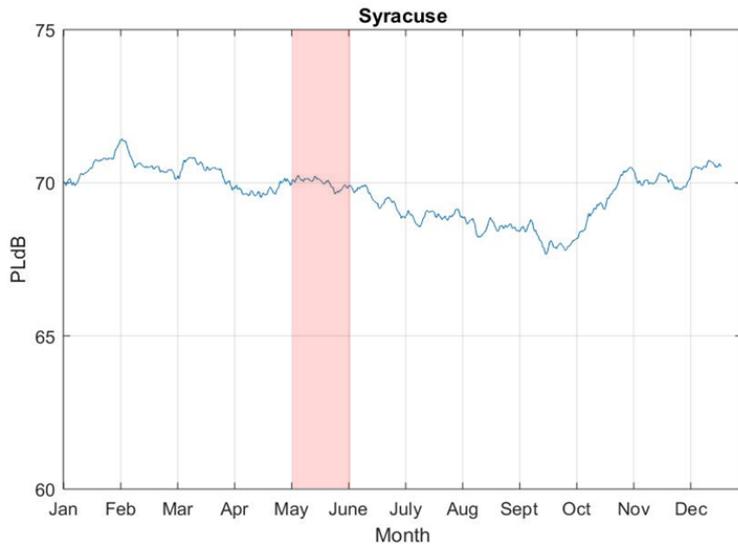
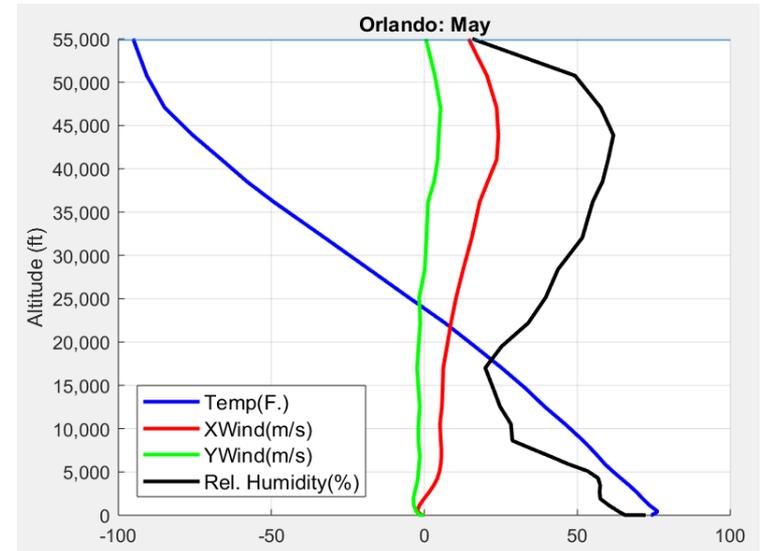
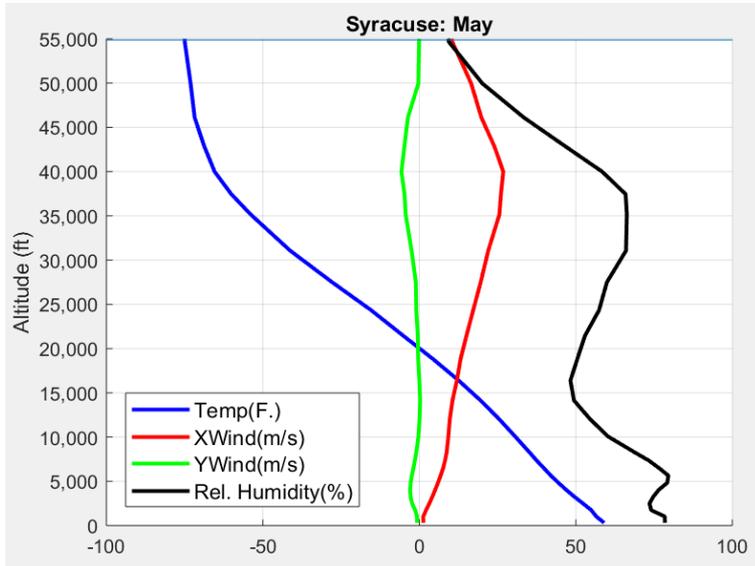
Monthly Atmospheric Variation



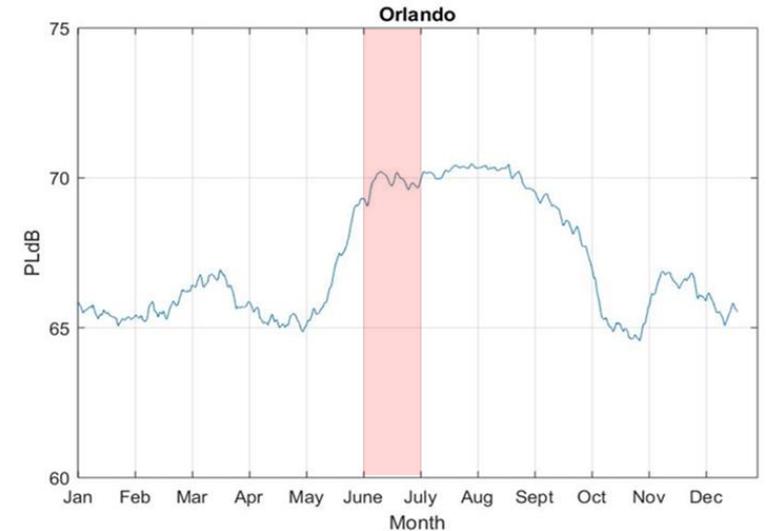
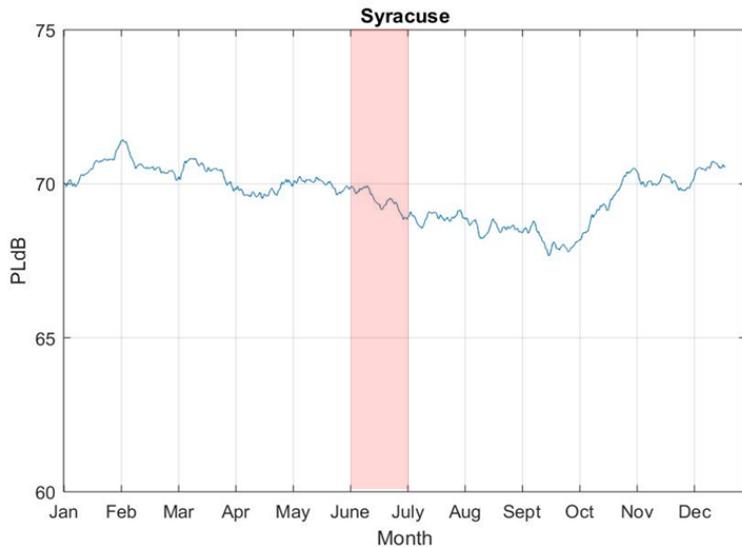
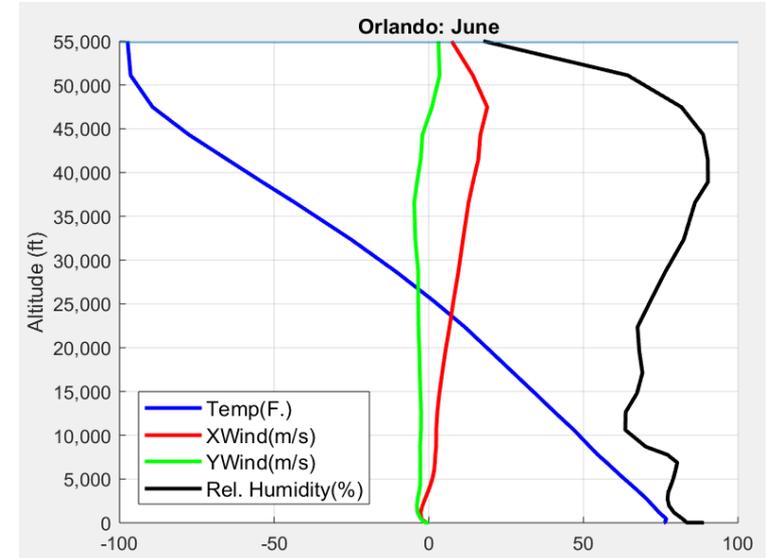
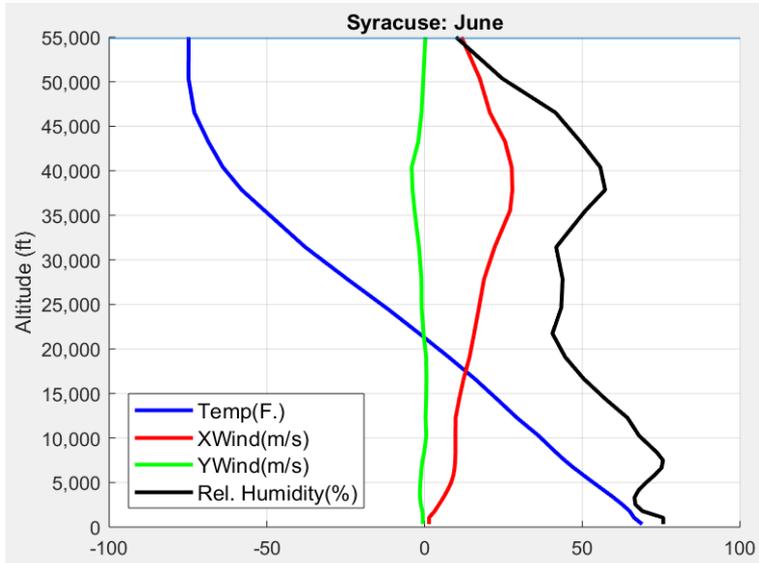
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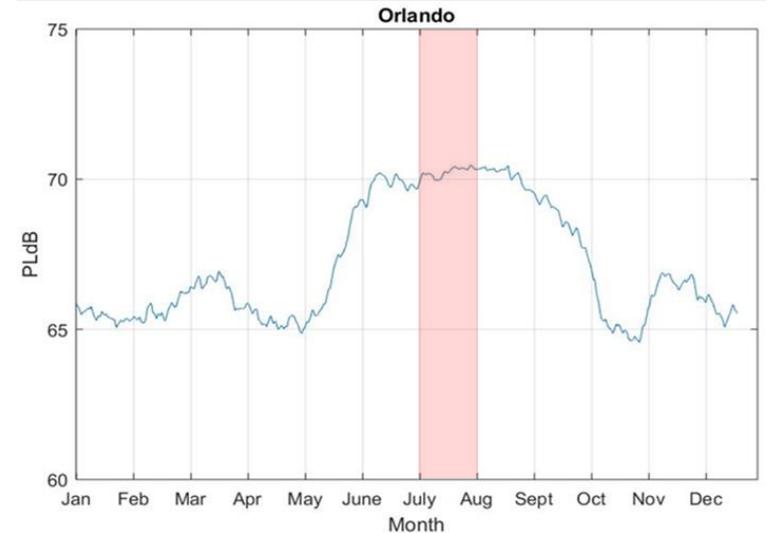
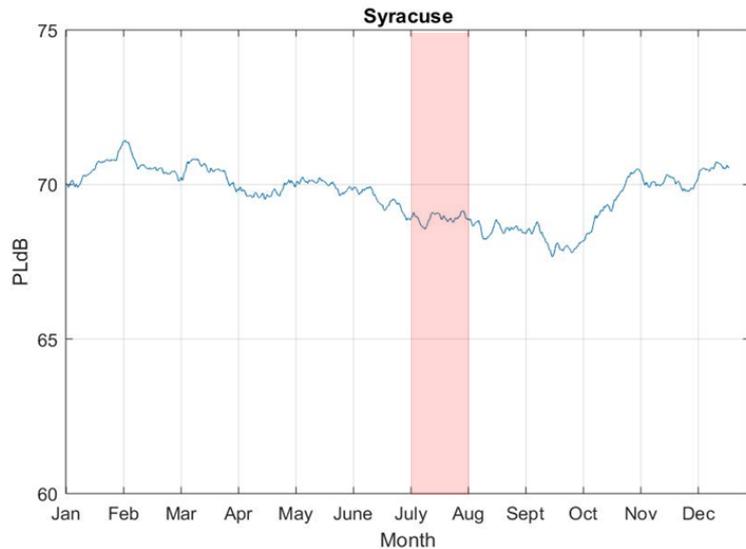
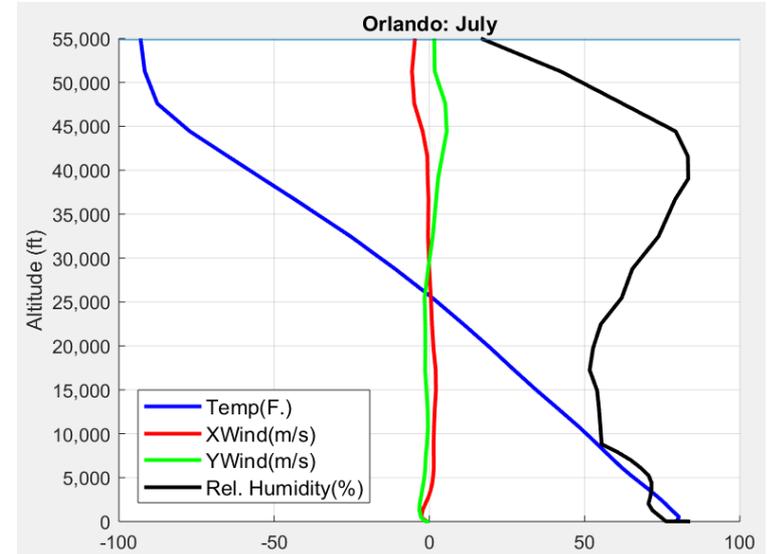
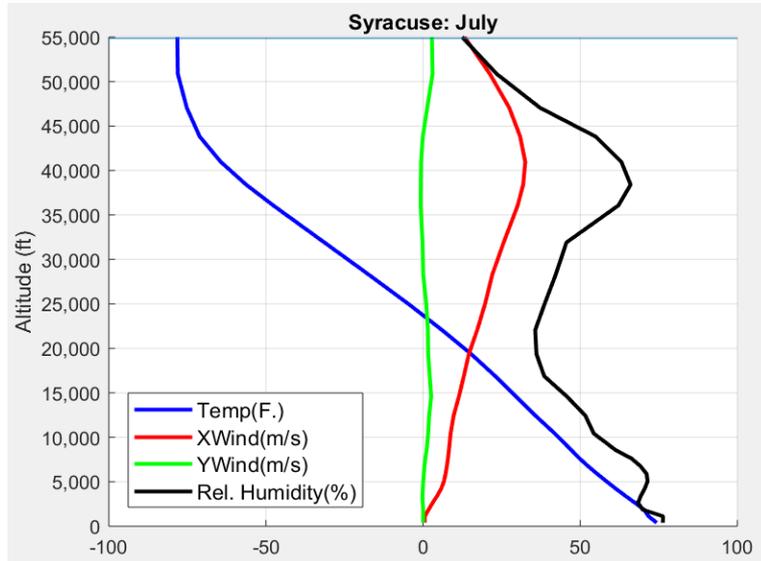
Monthly Atmospheric Variation



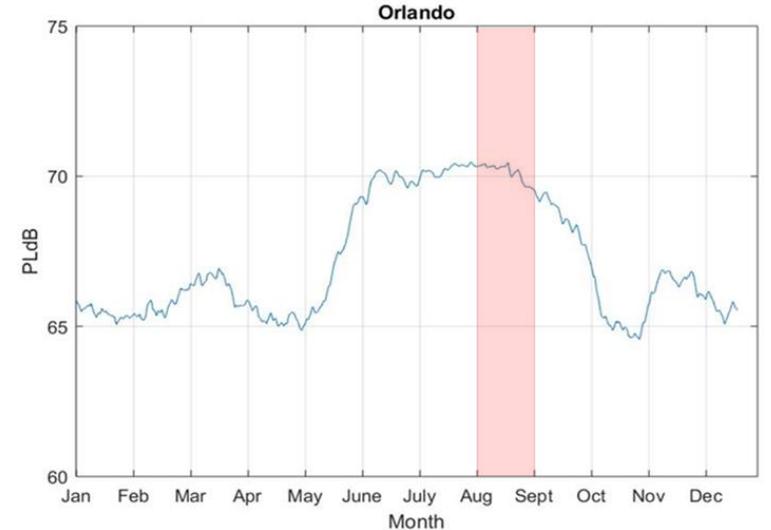
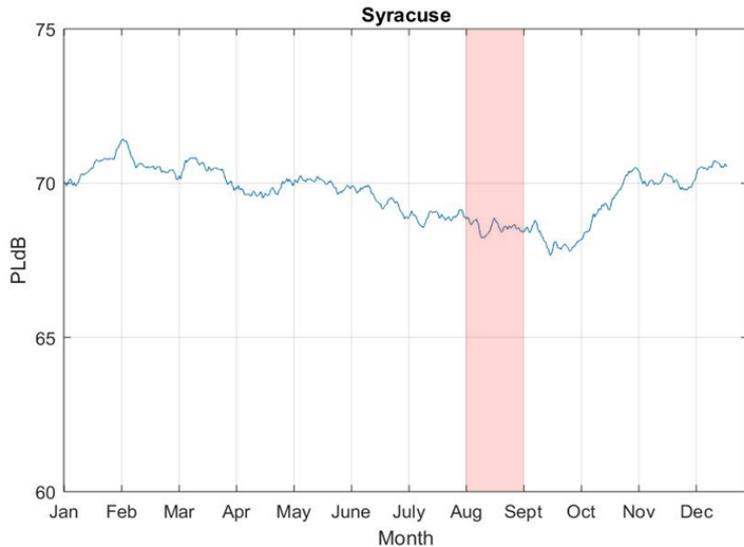
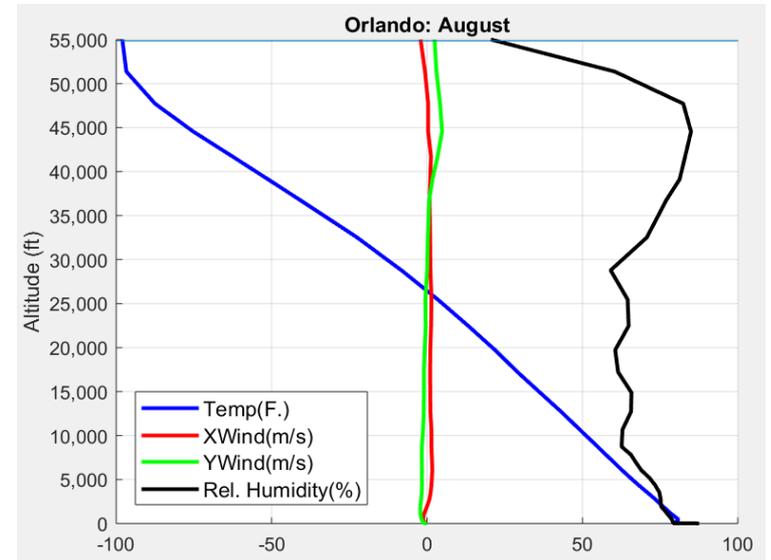
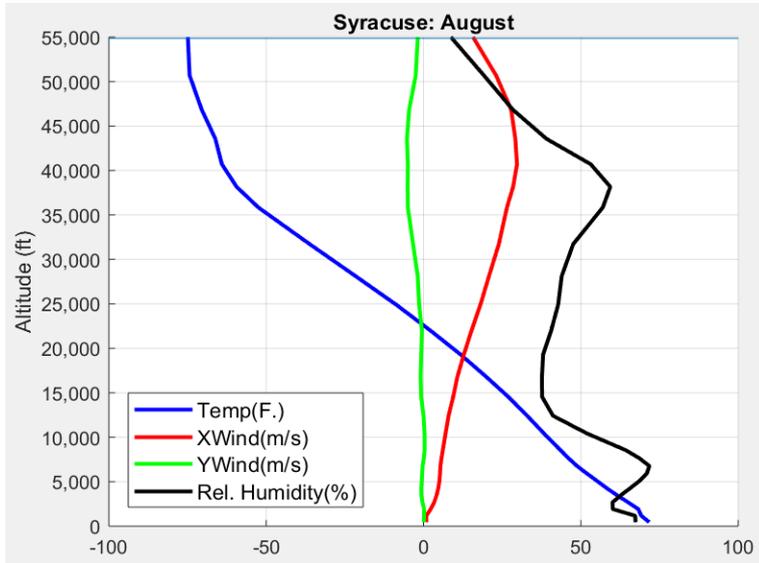
Monthly Atmospheric Variation



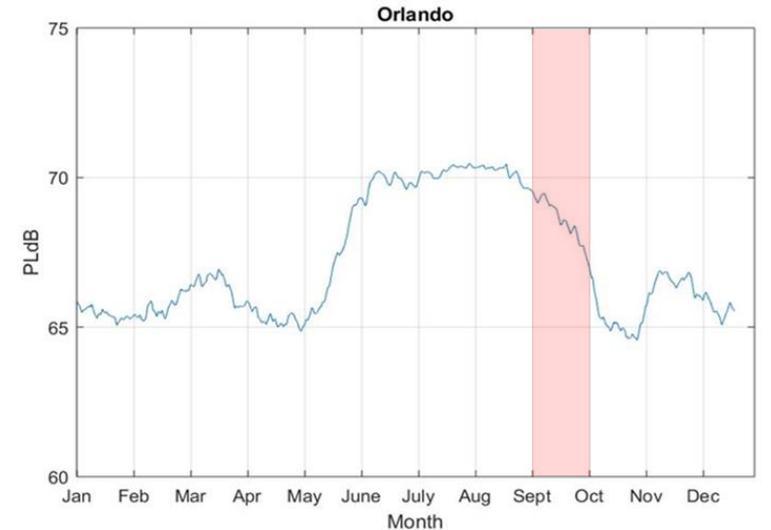
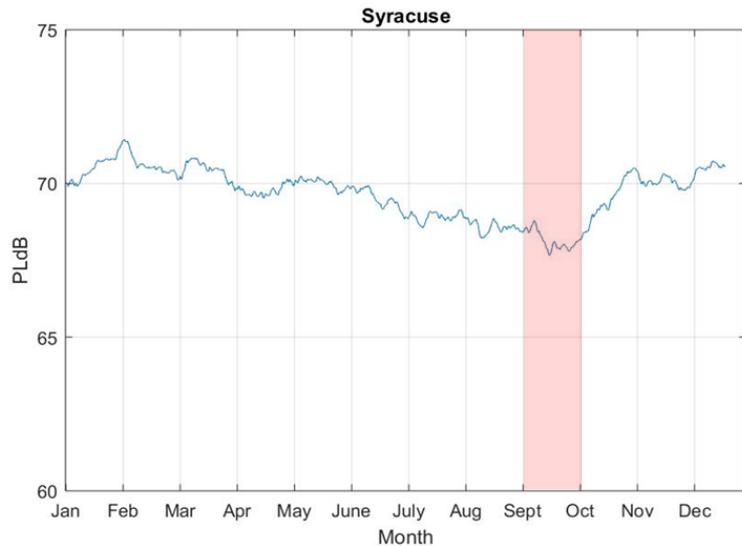
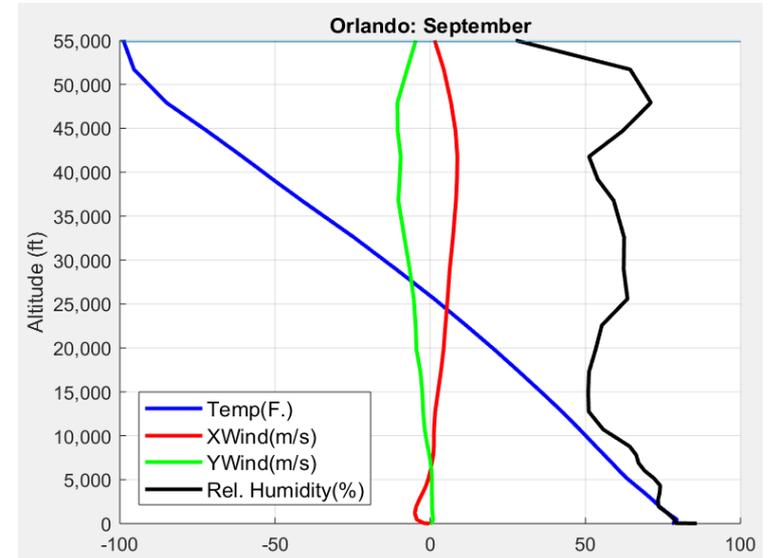
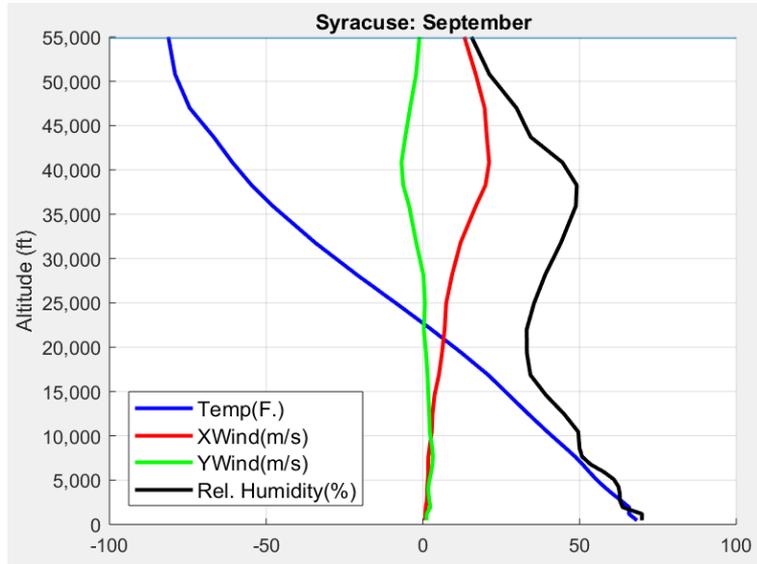
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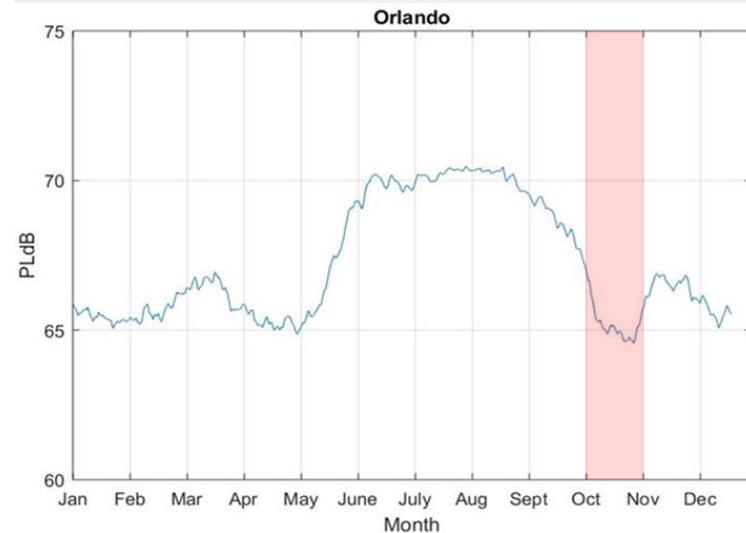
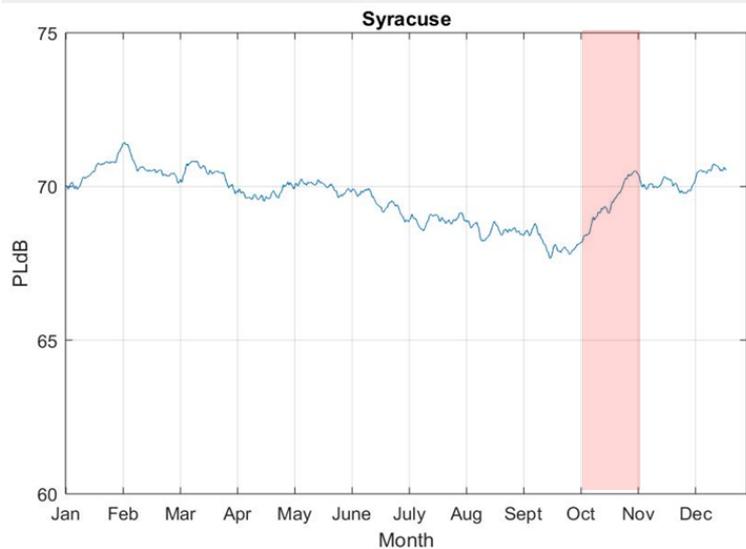
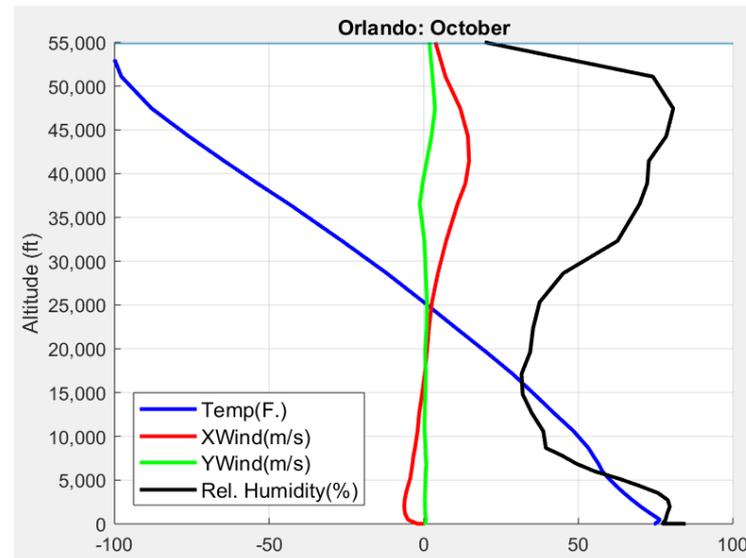
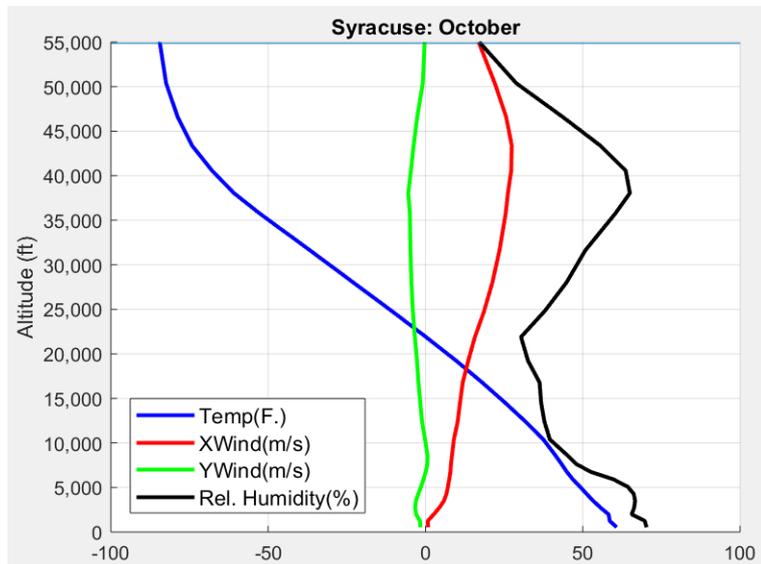
Monthly Atmospheric Variation



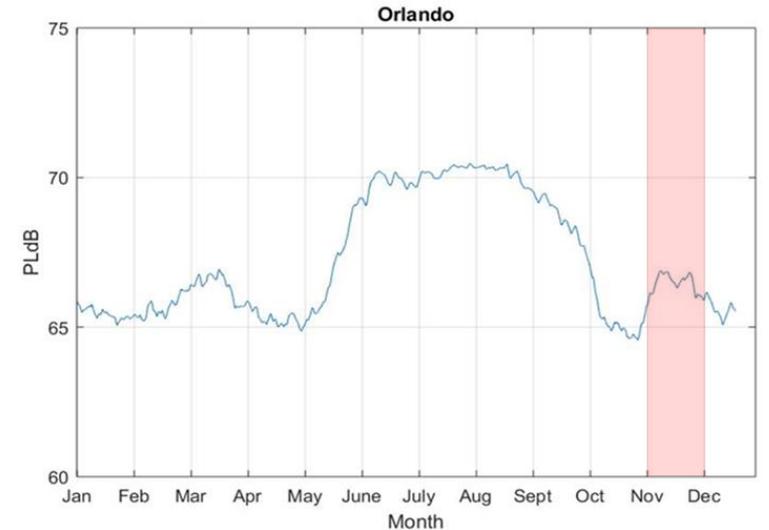
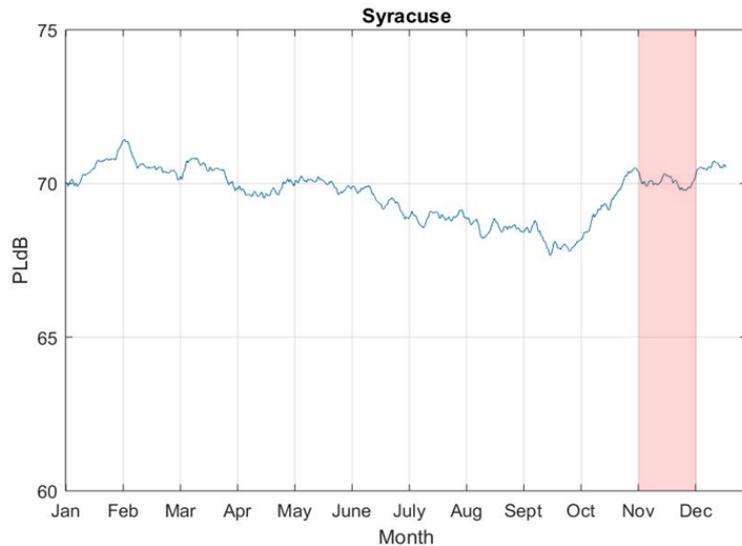
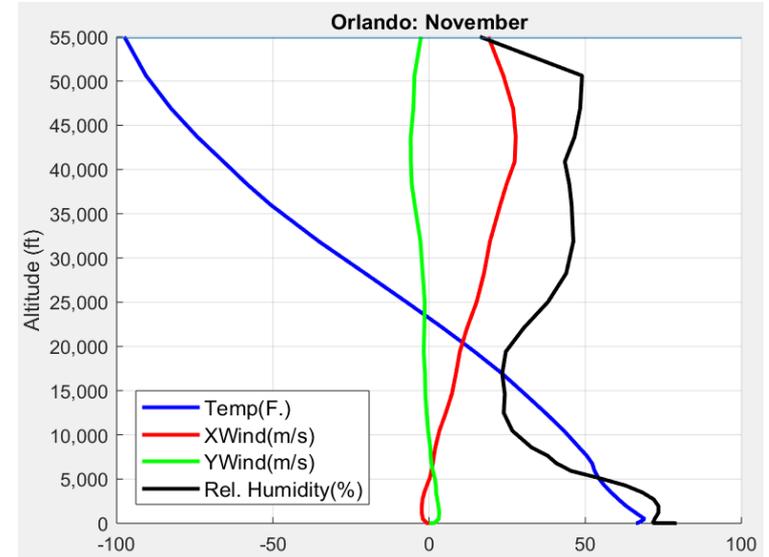
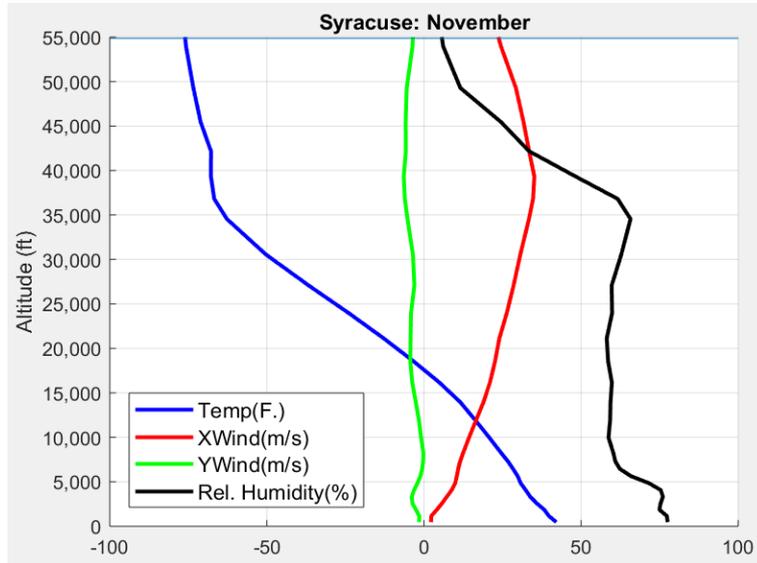
Monthly Atmospheric Variation



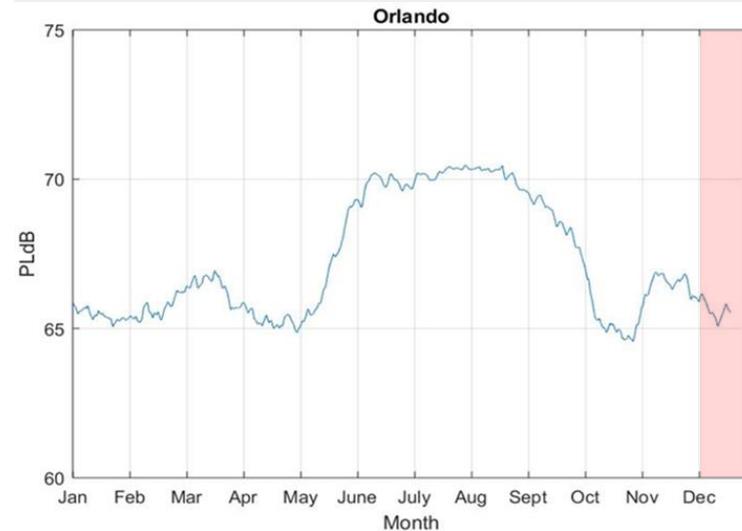
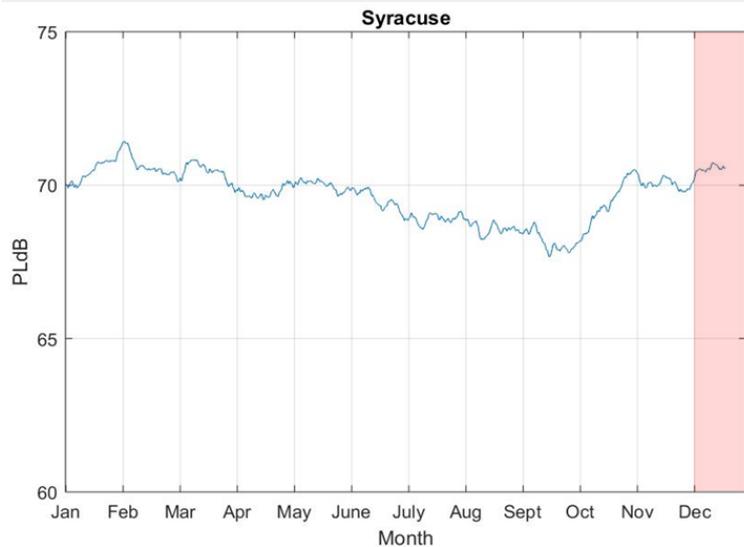
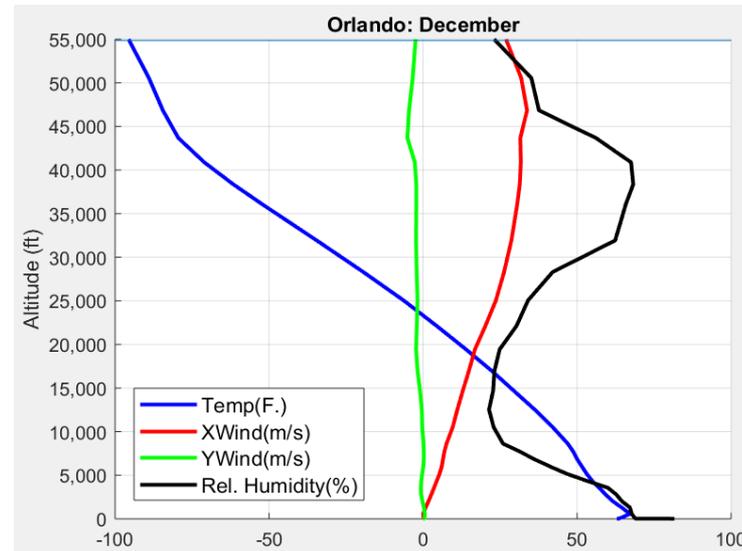
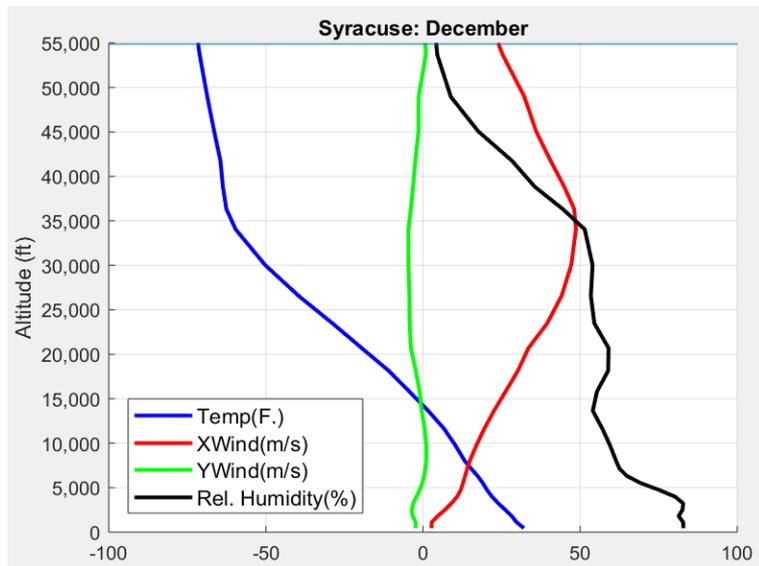
Monthly Atmospheric Variation



Monthly Atmospheric Variation



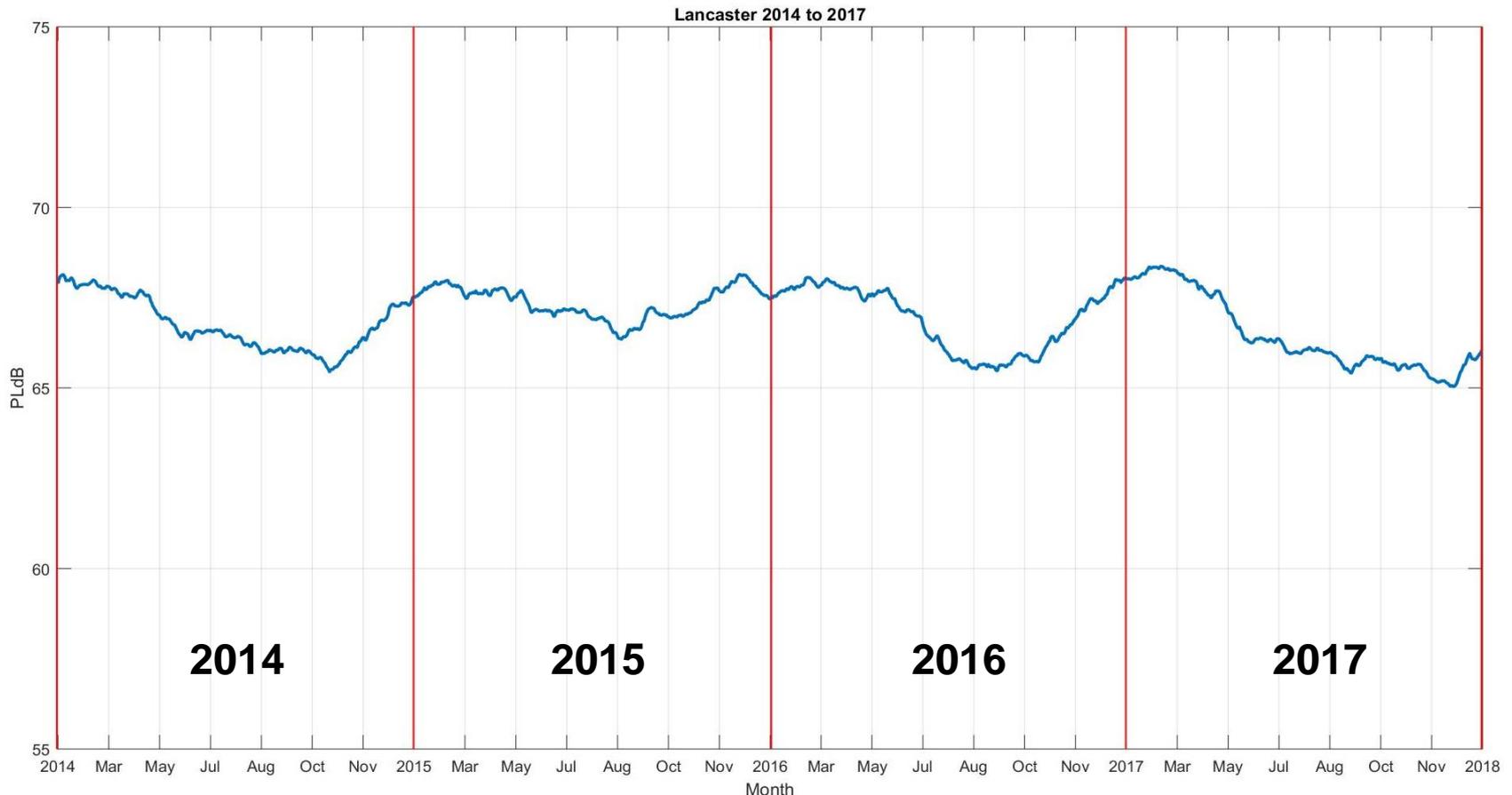
Monthly Atmospheric Variation



Year to Year Variation in Lancaster, CA



- Averages differ by < 1 PLdB
- PLdB drops during late summer/early fall and peaks at the end of winter

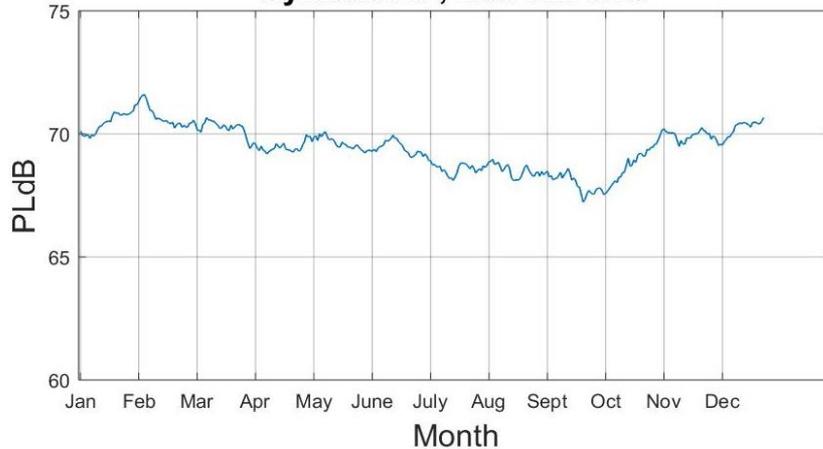


Time of Day vs. Loudness

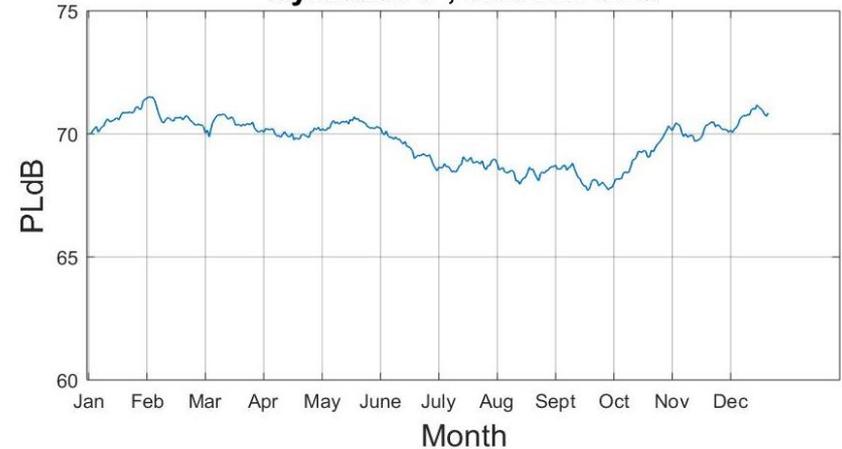


- Syracuse (colder inland climate) shows little variation with time of day. Turbulence may impact this.

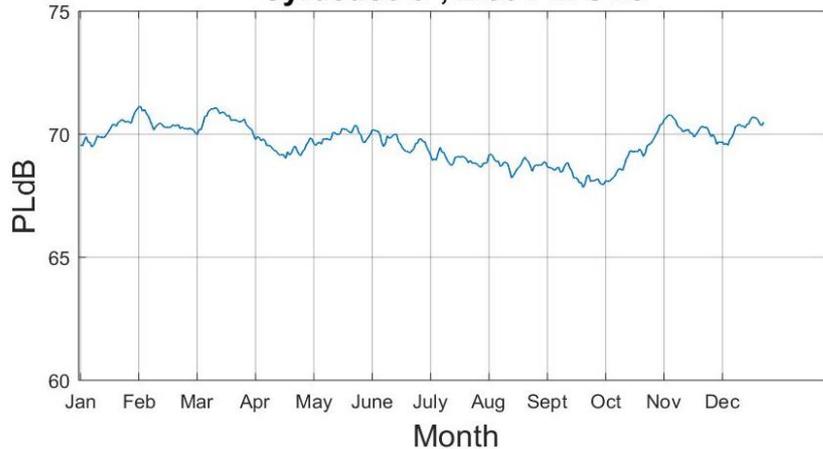
Syracuse 0°, 2:00 AM UTC



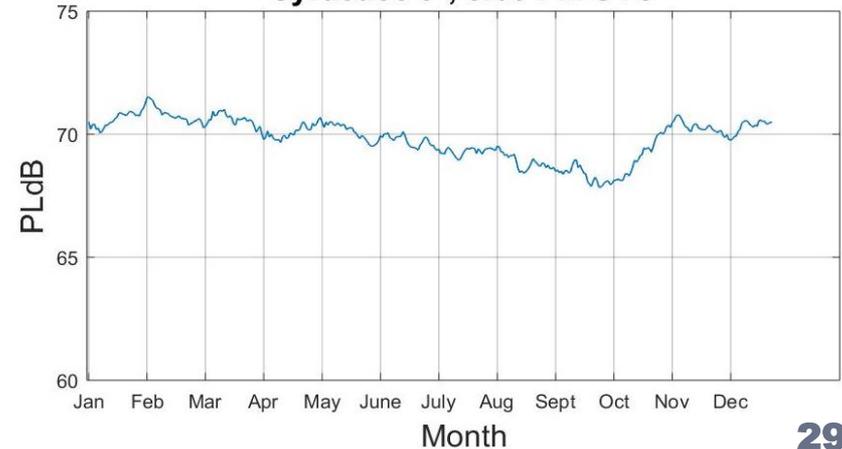
Syracuse 0°, 8:00 AM UTC



Syracuse 0°, 2:00 PM UTC



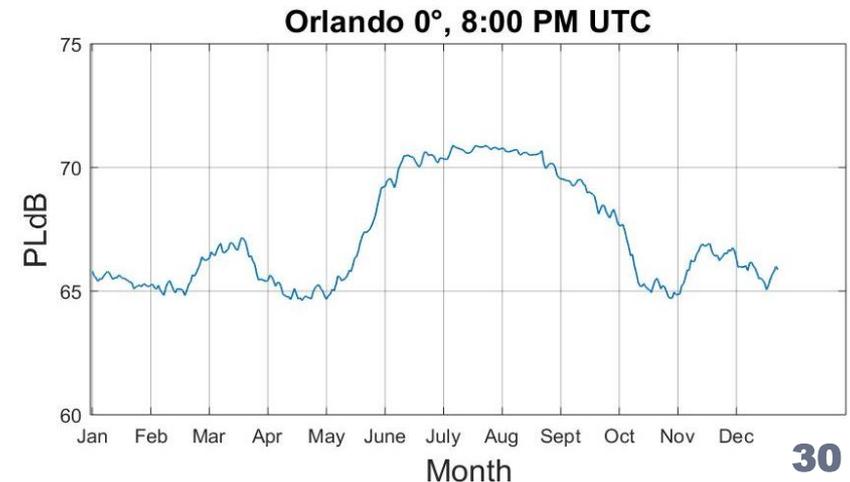
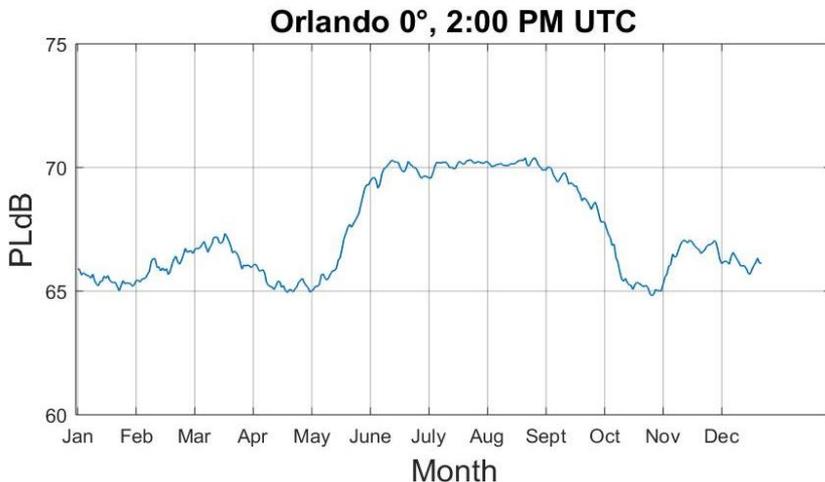
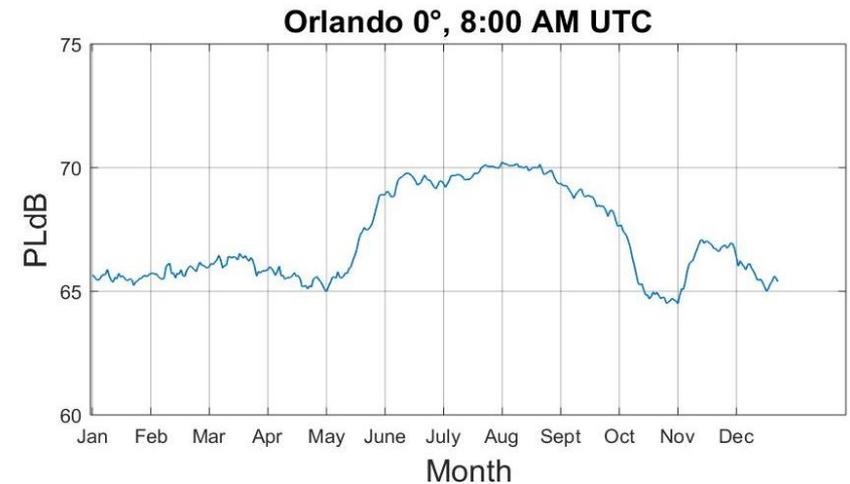
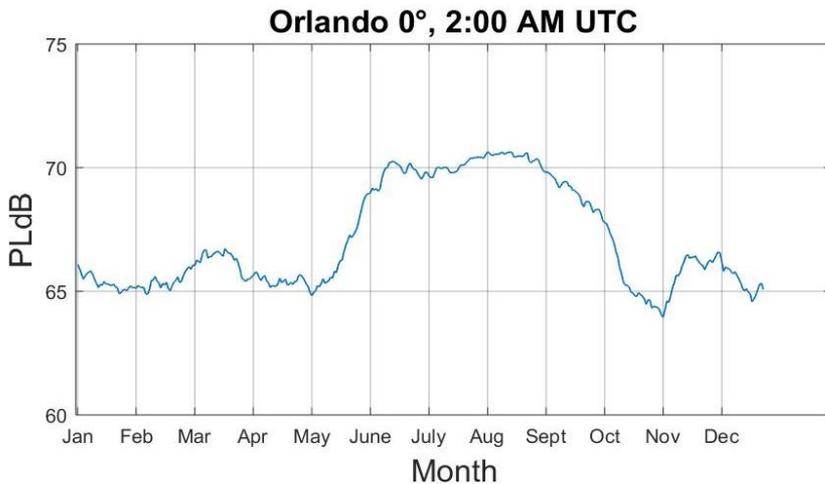
Syracuse 0°, 8:00 PM UTC



Time of Day vs. Loudness



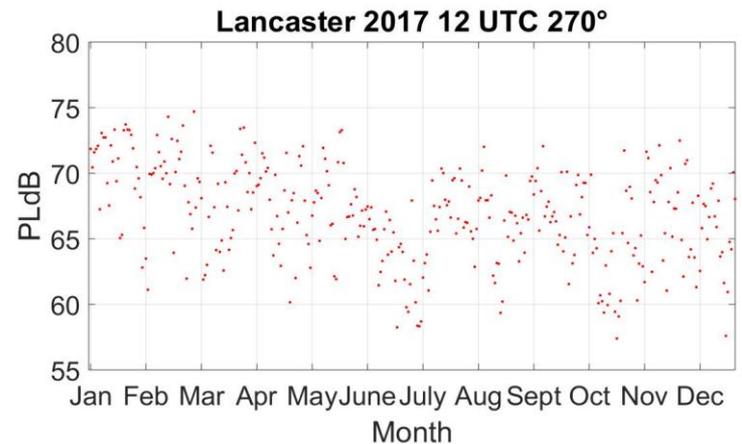
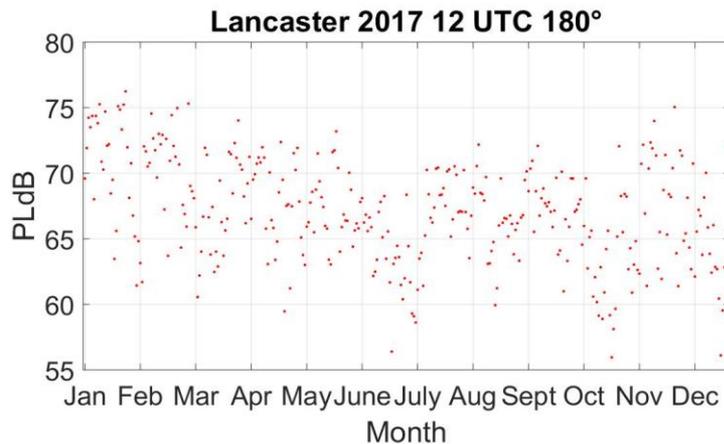
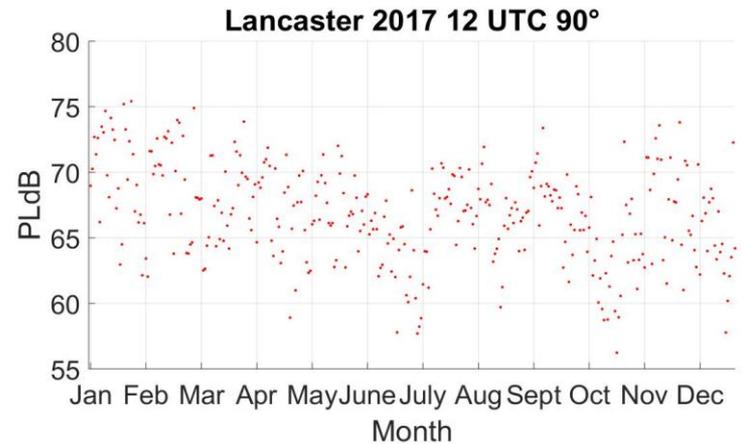
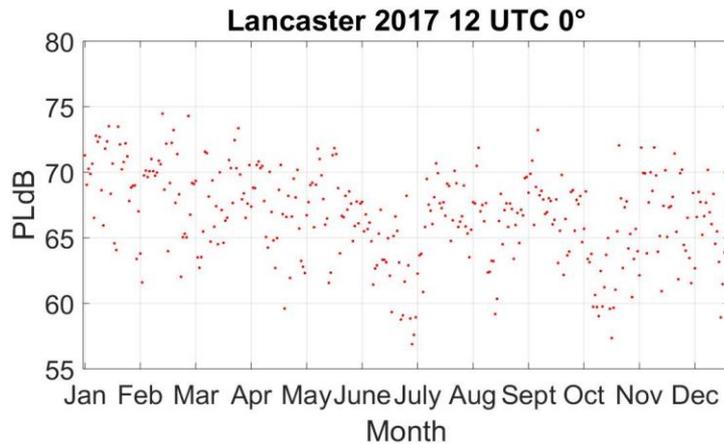
- Orlando (hot & humid climate) does show some variation with time of day but still not significant. Turbulence may impact this.



Heading Variation - Lancaster



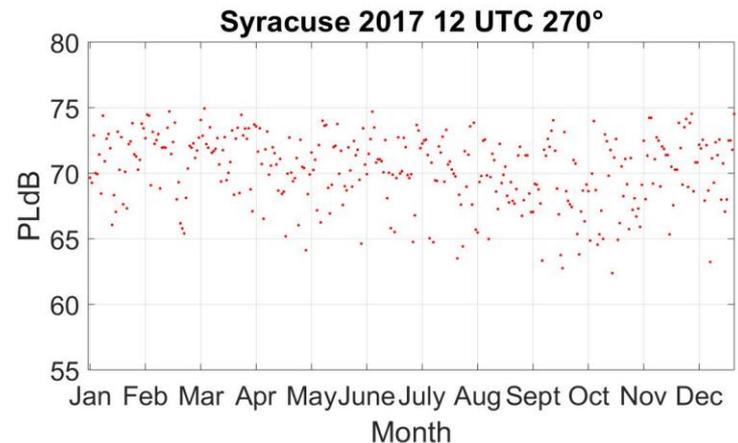
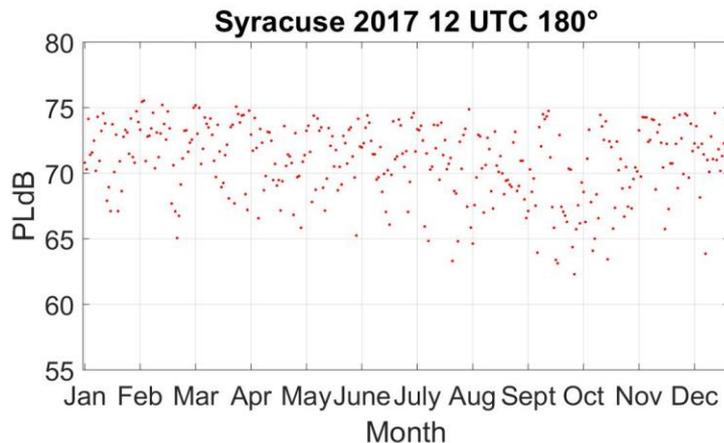
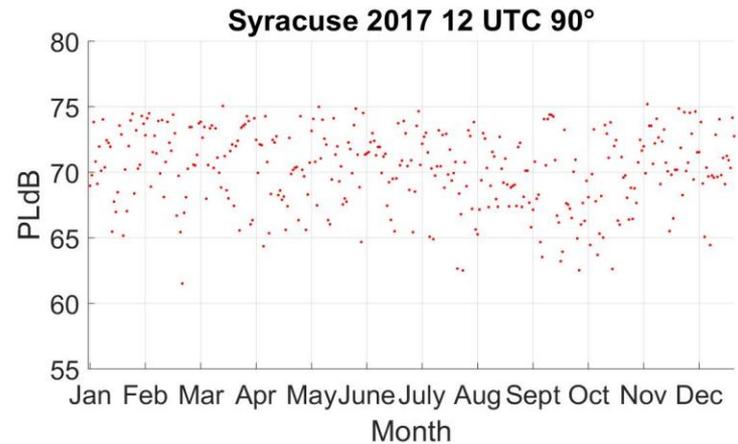
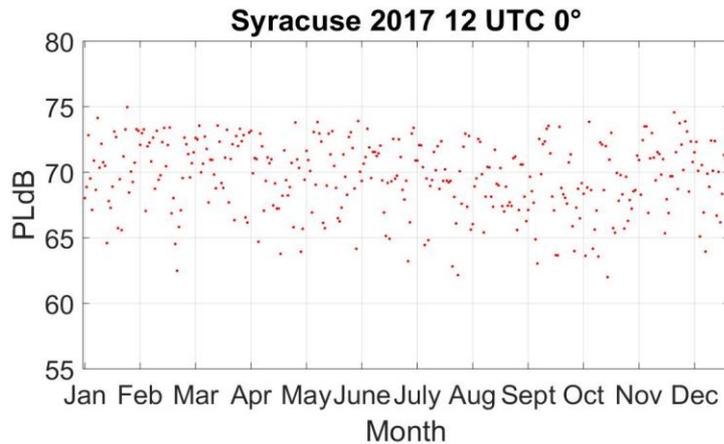
- Average differences are small with heading



Heading Variation - Syracuse



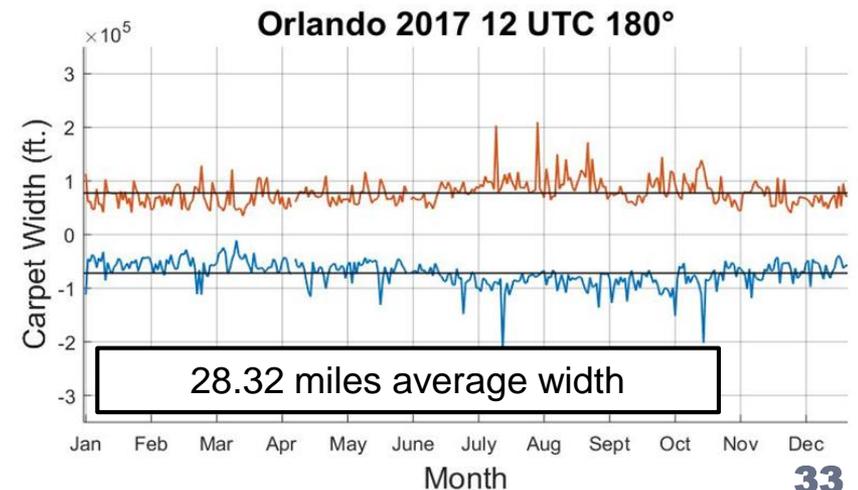
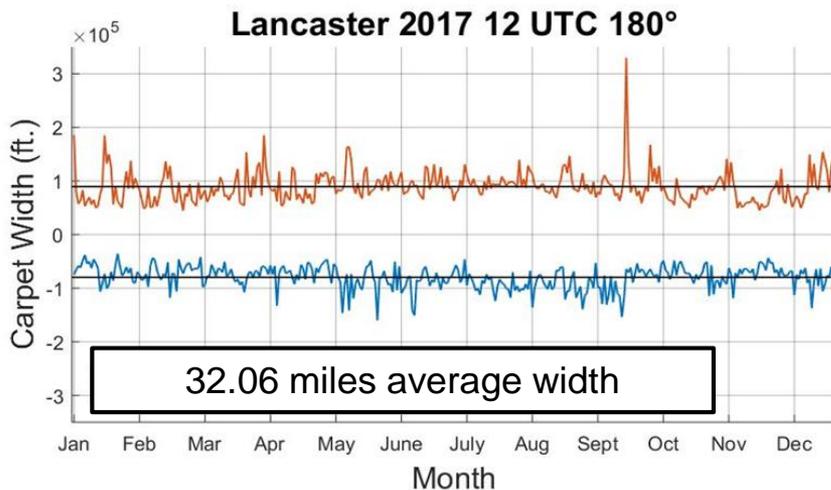
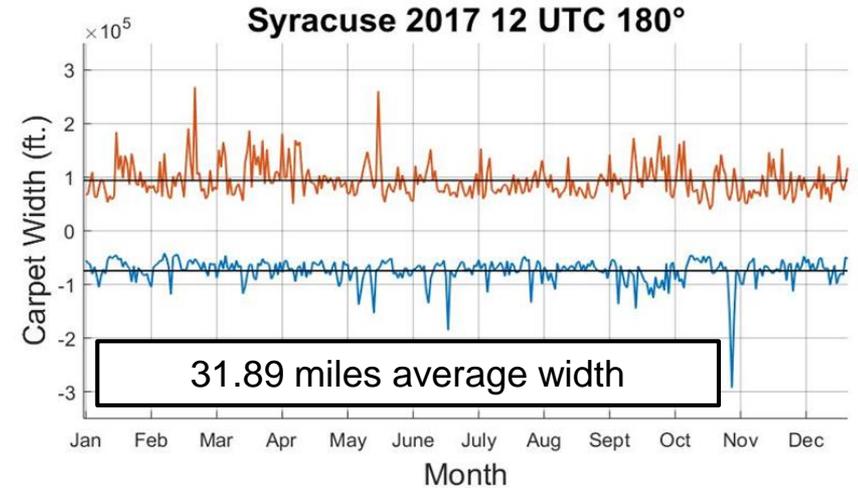
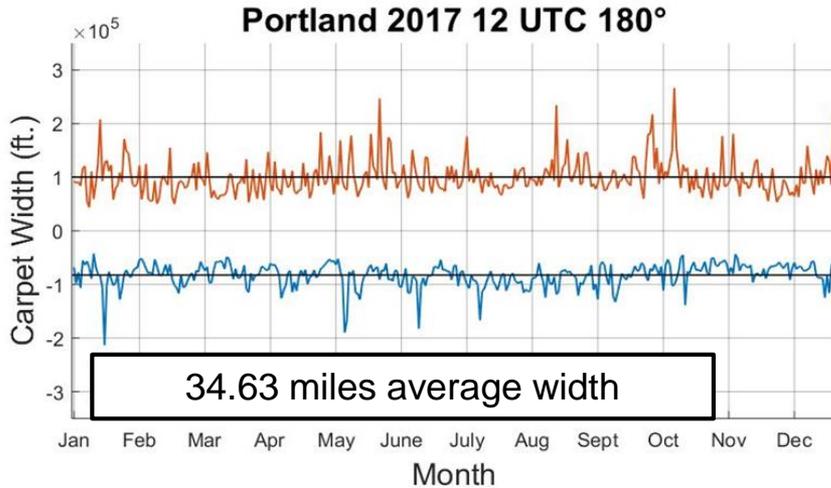
- Locations do have prevailing wind directions which should be kept in mind for test planning but daily variation may not be significant.



Carpet Widths



- Carpet widths can vary significantly but averages are around 30-35 mi



Summary



- Preliminary data generated for atmospheric effects on LBFD
- Various climatic regions studied
- Very few cases resulted in loudness at higher levels than for standard atmosphere
- In general, real atmospheres will result in 3-9 PLdB lower loudness levels
- Seasonal variations in average predicted loudness are in the 3-5 PLdB range
- Largest seasonal variations can be seen in the data for Orlando.
- Day to Day variations can vary as much as 10PLdB so need to not just focus on averages.
- Turbulence will have an impact on the results

Questions??

